Volume I of II (Appx1 to Appx1722)

2023-1935

In the United States Court of Appeals for the Federal Circuit

LYNK LABS, INC.,

Appellant,

-v-

SAMSUNG ELECTRONICS CO., LTD.,

Appellee.

On Appeal from the USPTO Patent Trial and Appeal Board
No. IPR2021-01347

Joint Appendix

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Volume I

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Volume II

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Paper 27
Date: March 13, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO. LTD.,
Petitioner,

v.

LYNK LABS, INC.,
Patent Owner.

IPR2021-01347
Patent 10,966,298 B2

Before JON B. TORNQUIST, STEPHEN E. BELISLE, and SCOTT RAEVSKY, *Administrative Patent Judges*.

TORNQUIST, *Administrative Patent Judge*.

JUDGMENT
Final Written Decision
Determining All Challenged Claims Unpatentable
35 U.S.C. § 318(a)

I. INTRODUCTION

A. Background and Summary

Samsung Electronics Co. Ltd. ("Petitioner") filed a Petition (Paper 1, "Pet.") requesting an *inter partes* review of claims 1–25 ("Challenged Claims") of U.S. Patent No. 10,966,298 B2 (Ex. 1001, "the '298 patent"). Lynk Labs, Inc. ("Patent Owner") did not file a Preliminary Response to the Petition. On March 15, 2022, we instituted review of all Challenged Claims of the '298 patent. Paper 5 ("Institution Decision" or "Inst. Dec.").

Patent Owner subsequently filed a Response (Paper 14, "PO Resp."), to which Petitioner filed a Reply (Paper 16, "Pet. Reply"), and Patent Owner filed a Sur-Reply (Paper 19, "Sur-Reply").

Petitioner relies, *inter alia*, upon the declaration and reply declaration of R. Jacob Baker, Ph.D. (Exs. 1002, 1118). Patent Owner submits a declaration from Thomas L. Credelle (Ex. 2001).

On June 21, 2022, Patent Owner disclaimed claim 18–20 of the '298 patent. Ex. 2004, 3. Thus, we do not address claims 18–20 in this Decision. *See Apple Inc. v. MPH Technologies OY*, 2020 WL 6494252, *5, IPR2019-00826, Paper 25 at 10–11 (PTAB Nov. 4, 2020).

An oral hearing was held on December 13, 2022, and a transcript of the hearing is included in the record (Paper 26, "Tr.").

For the reasons that follow, we conclude that Petitioner has proven by a preponderance of the evidence that claims 1–17 and 21–25 of the '298 patent are unpatentable.

B. Real Parties-in-Interest

Petitioner identifies itself and Samsung Electronics America, Inc. as the real parties-in-interest. Pet. 1.

Patent Owner identifies itself as the real party-in-interest. Paper 6, 1.

C. Related Matters

The parties identify *Samsung Electronics Co. v. Lynk Labs, Inc.*, No. 1:21-cv-02665 (N.D. Ill.) (consolidated with *Lynk Labs, Inc. v. Samsung Electronics Co., Ltd.*, No. 1:21-cv-05126 (N.D. Ill.)) and *Lynk Labs, Inc. v. Samsung Electronics Co.*, No. 1:21-cv-05021-MHC (N.D. Ga.) as related matters. Pet. 1; Paper 6, 1; Paper 23, 2.

D. The '298 Patent

The '298 patent is directed to "alternating current ('AC') driven LEDs, LED circuits and AC drive circuits and methods." Ex. 1001, 1:65–67. The '298 patent explains that "LEDs are intrinsically DC devices that only pass current in one polarity and historically have been driven by DC voltage sources." *Id.* at 2:4–6. "With proper design considerations," however, the '298 patent reports that "LEDs may be driven more efficiently with AC than with DC drive schemes." *Id.* at 2:11–12.

In one aspect of the invention, a lighting system is provided having one or more LED circuits, with each LED circuit having at least two diodes connected to each other in opposing parallel relation. *Id.* at 4:30–34. The diodes of the '298 patent may include "any type of diode capable of allowing current to pass in a single direction, including but not limited to, a standard diode, a schottky diode, a zener diode, and a current limiting diode." *Id.* at 4:34–38.

Figure 37 is reproduced below:

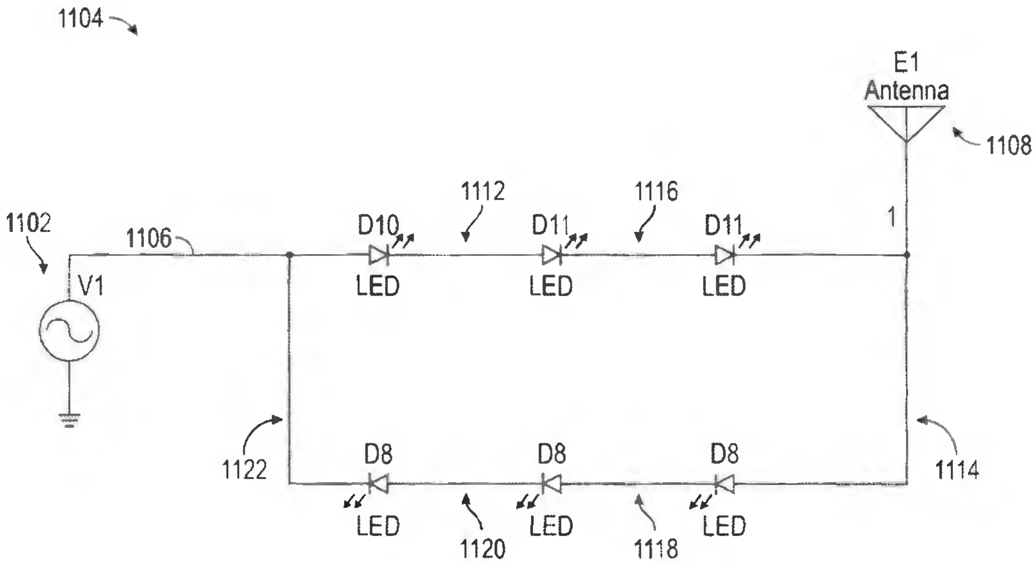


Figure 37 is a schematic view of a preferred embodiment of the ’298 patent and shows circuit 1104. *Id.* at 12:30–31, 20:16–17. As show in Figure 37, in circuit 1104 “an alternating electric field is provided to a first transmission conductor by a signal generator 1102 and a second transmission conductor is provided by an antenna 1108.” *Id.* at 20:17–20. The ’298 patent explains that side 1112 of the directional circuit show in Figure 37 is “relatively more positive,” and sides 1114–1122 are “relatively less positive.” *Id.* at 20:22–25.

The ’298 patent explains that proximity may be sensed using impedance changes within the directional circuit caused by “approaching any of the directional circuits or transmission conductors” with a conductive substance, such as a person or metallic material, “thereby changing the circulation of current flow within the directional circuit by changes in impedance through the capacitance of the conductive substance.” *Id.* at 20:25–36.

E. Illustrative Claims

Petitioner challenges claims 1–17 and 21–25 of the ’298 patent. Pet. 2–3. Claim 1, reproduced below, is illustrative of the challenged claims:

> 1. An apparatus comprising:
>
> a first device including a first circuit having a first transmission conductor and a first inductor, wherein said first circuit is configured to use at least the first inductor to transmit power from the first device wirelessly; and
>
> a second device including
>
> (a) at least one LED,
>
> (b) a second circuit configured to detect contact with a conductive substance via capacitive sensing for controlling the at least one LED, and
>
> (c) a third circuit having a second transmission conductor and a second inductor, wherein said second device is configured to use at least the second inductor to receive power wirelessly from said first device for powering the apparatus.

Ex. 1001, 27:21–36.

F. Prior Art and Asserted Grounds

Petitioner asserts that claims 1–17 and 21–25 would have been unpatentable on the following grounds (Pet. 2–3):

Claim(s) Challenged[1]	35 U.S.C. §[2]	Reference(s)/Basis
1, 3, 4, 10–15, 17–21, 23	103	Birrell[3], Logan[4]
2	103	Birrell, Logan, Johnson[5]
3, 10–12, 21	103	Birrell, Logan, Zhang[6]
5	103	Birrell, Logan, Sembhi[7]
6, 18, 24	102	Birrell
7, 8, 25	103	Birrell, Logan, Camras[8]
9	103	Birrell, Logan, Gleener[9]
16	103	Birrell, Logan, Rahmel[10]
22	103	Birrell, Logan, Sontag[11]

[1] As noted above, Patent Owner disclaimed claims 18–20. Here, for context, we reproduce Petitioner's original challenges to claims 1–25 of the '298 patent.
[2] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. §§ 102 and 103, effective March 16, 2013. Because the '298 patent claims priority to an application filed October 6, 2008, and because neither party argues otherwise, we apply the pre-AIA versions of §§ 102 and 103 in this Decision. *See* 35 U.S.C. § 100(i)(1)(B).
[3] AU Application No. 2003100206, published July 17, 2003. Ex. 1005 ("Birrell").
[4] GB 2 202 414 A, published September 21, 1988. Ex. 1006 ("Logan").
[5] US 5,028,859, issued July 2, 1991. Ex. 1007 ("Johnson").
[6] US Patent Publication No. 2002/0021573 A1, published February 21, 2002. Ex. 1022 ("Zhang").
[7] US Patent Publication No. 2002/0060530 A1, published May 23, 2002. Ex. 1008 ("Sembhi").
[8] US Patent Publication No. 2002/0030194 A1, published March 14, 2002. Ex. 1009 ("Camras").
[9] US Patent Publication No. 2002/0175870 A1, published November 28, 2002. Ex. 1010 ("Gleener").
[10] US 6,882,128 B1, issued April 19, 2005. Ex. 1011 ("Rahmel").
[11] US 4,654,880, issued March 31, 1987. Ex. 1012 ("Sontag").

II. ANALYSIS

A. Legal Standards

A patent claim is unpatentable under 35 U.S.C. § 103(a) if the differences between the claimed subject matter and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. *See KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 406 (2007). The question of obviousness is resolved on the basis of underlying factual determinations, including (1) the scope and content of the prior art; (2) any differences between the claimed subject matter and the prior art; (3) the level of ordinary skill in the art; and (4) if in the record, objective evidence of nonobviousness.[12] *Graham v. John Deere Co.*, 383 U.S. 1, 17–18 (1966).

Anticipation requires that a reference disclose each and every element of the claimed invention, either expressly or inherently, and that those elements are "arranged or combined in the same way as in the claim." *In re Gleave*, 560 F.3d 1331, 1334 (Fed. Cir. 2009) (quoting *Net MonyIN, Inc. v. VeriSign, Inc.*, 545 F.3d 1359, 1370 (Fed. Cir. 2008)).

B. Level of Ordinary Skill in the Art

In determining the level of skill in the art, we consider the type of problems encountered in the art, the prior art solutions to those problems, the rapidity with which innovations are made, the sophistication of the technology, and the educational level of active workers in the field. *Custom*

[12] Patent Owner does not present objective evidence of non-obviousness in this case.

Accessories, Inc. v. Jeffrey-Allan Indus., Inc., 807 F.2d 955, 962 (Fed. Cir. 1986).

Petitioner contends a person of ordinary skill in the art as of the priority date of the '298 patent "would have had at least a bachelor's degree in electrical engineering, computer engineering, computer science, physics, or the equivalent, and two or more years of experience with LED devices and/or related circuit design, or a related field." Pet. 4 (citing Ex. 1002 ¶¶ 20–21).

Patent Owner contends there are "several problems" with Petitioner's proposed definition. PO Resp. 11. In particular, Patent Owner contends the "and/or" qualifier and addition of "or a related field" could be read to allow an individual with no experience with LED devices to be a person of ordinary skill in the art. *Id.*

Upon review of the parties' arguments, the prior art of record, and the '298 patent, we agree with Patent Owner that one of ordinary skill in the art would have had experience working with LEDs and/or LED circuit design. Thus, we adopt Patent Owner's definition of one of ordinary skill in the art. We note, however, that neither party asserts that the outcome of this case rests on resolving the small differences between the parties' definitions of the ordinarily skilled artisan.

C. Claim Construction

In this proceeding, the claims of the '298 patent are construed "using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. [§] 282(b)." 37 C.F.R. § 42.100(b). Under that standard, the words of a claim are generally given their "ordinary and customary meaning," which is the meaning the term would have had to a person of ordinary skill at the time of the invention in the context of the

entire patent including the specification. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc).

Neither party contends any terms of the '298 patent require construction. Pet. 5–6; PO Resp. 12. Upon review of the parties' arguments and supporting evidence, we agree that no terms require express construction. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.")).

D. Claims 1, 3, 4, 10–15, 17, 21, and 23 over Birrell and Logan

Petitioner contends the subject matter of claims 1, 3, 4, 10–15, 17, 21, and 23 would have been obvious over the combined disclosures of Birrell and Logan. Pet. 7–46.

1. Birrell

Birrell discloses "systems and methods for connecting electrical devices to power sources." Ex. 1005, 2:3–5. Figure 1 of Birrell is reproduced below:

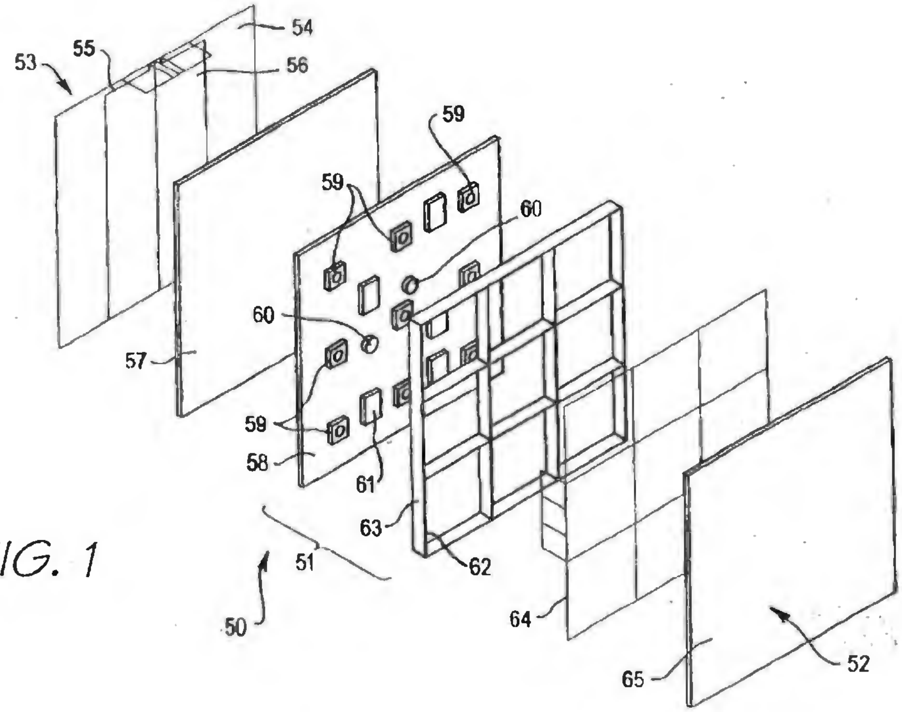


FIG. 1

Figure 1 is an exploded view of a light tile for use in the lighting system of Birrell. *Id.* at 13:31–33. As shown in Figure 1, lighting tile 50 has "a thin body 51 having opposite first and second major surfaces" 52 and 53. *Id.* at 14:27–29. Back face 53 of body 51 includes metallized strips 55 and 56, which act as electrical coupling elements for tile 50 to "enable it to be capacitively coupled to a power source." *Id.* at 14:31–37. Flexible magnetic sheet 57 provides an active magnetic force to secure the lighting tile to a magnetic receptive element. *Id.* at 15:5–8.

Printed circuit board subassembly 58 supports LEDs 59 (which are set out in a 3 x 3 grid format), sensors 60, and microcontroller 61. *Id.* at 15:15–36. Circuit board 58 also supports power supply circuitry, such as bridge rectifiers and energy storage components, as well as data circuits that are used to modulate and demodulate signals. *Id.* at 16:6–10. Support frame 62 provides physical protection for the lighting components, and metallized

polymer film 64 acts as a touch sensor to enable lighting tile 50 to be controlled, as least to some extent, by human touch on first major surface 52 of the tile body. *Id.* at 16:11–21. "The final component of the tile body 51 is a front cover which provides an optical correction for emitting light" using diffusion, diffraction, "focusing or other applied optical techniques." *Id.* at 16:27–30.

Figure 8 of Birrell is reproduced below:

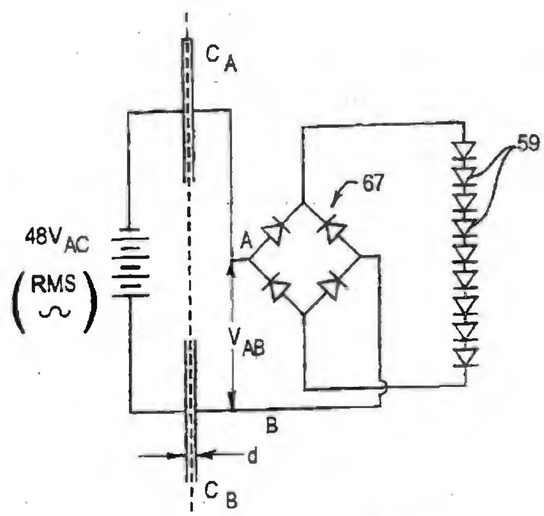


FIG 8

Figure 8 is a simplified circuit diagram of the lighting element of Birrell. *Id.* at 20:26–27. In the circuit depicted in Figure 8, a 48 Volt AC power supply is coupled to capacitors C_A and C_B and used to power LEDs 59. *Id.* at 21:15–34, 22:5–13. Diodes 67 are configured to form a bridge rectifier, ensuring "that light is emitted from the LEDs during both the positive and negative cycles of the AC power supply." *Id.* at 19:1–7.

1. Logan

Logan discloses methods of "transmitting power and/or data through a solid member, such as an instrument panel or bulkhead." Ex. 1006, 1:3–5. Figure 2 of Logan is reproduced below:

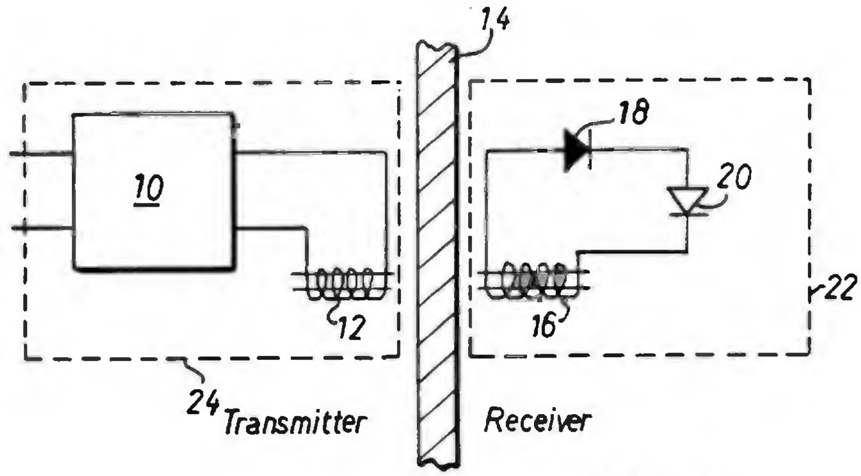


Fig 2

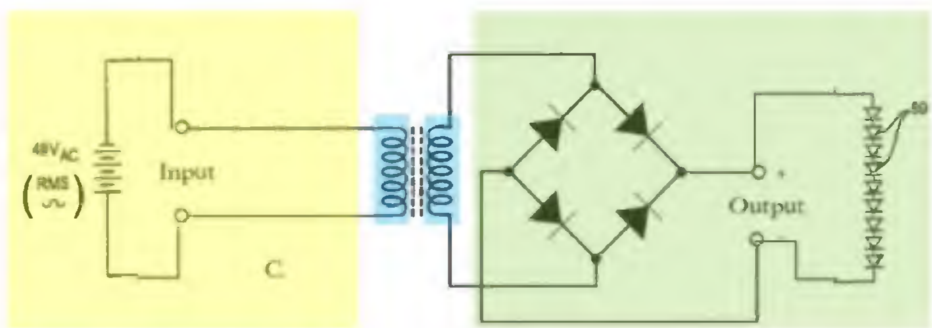
Figure 2 is a circuit diagram of an arrangement for transmitting power through a panel. *Id.* at 3:9–11. In Figure 2, oscillator 10 energizes transmitter coil 12 to create an alternating electromagnetic flux that penetrates through panel/bulkhead 14 and induces an electromagnetic force in receiver coil 16. *Id.* at 3:19–23. Diode 18 is connected in series with receiver coil 16 and LED 20, and power from receiver 16 is used to power LED 20. *Id.* at 4:12–14. According to Logan, elements 16, 18, and 20 may be encapsulated to form unitary component 22. *Id.* at 4:12–16.

Logan explains that it is "preferred to use iron-cored transmission and pick-up coils 12, 16 . . . so as to produce a concentrated magnetic field." *Id.* at 6:3–5. Due to this concentrated magnetic field, Logan explains that "indicator lamps can be densely packed without interference problems arising since cross-talk between lamps sharing the same panel will not provide sufficient coil voltage to overcome the LED forward voltage of other receiver devices." *Id.* at 6:5–11.

2. *Analysis: Claim 1*

a) Limitations of Claim 1

Petitioner asserts that one of ordinary skill in the art would have combined the disclosures of Birrell and Logan in order to wirelessly transmit power using inductive coupling. Pet. 13. Petitioner contends the resulting apparatus would have the configuration shown in Demonstrative A, below:



Demonstrative A

Demonstrative A, above, is Petitioner's depiction of the combination of portions of the circuit depicted in Figure 8 of Birrell and portions of the circuit depicted in Figure 2 of Logan. *Id.* at 17. In the combined apparatus of Birrell and Logan, capacitors C_A and C_B of Birrell are replaced by the transmitter coil and receiver coil of Logan, with the transmitter coil (blue highlight) connected to the 48V AC input of Birrell via a transmission conductor (yellow box) and the receiver coil (blue highlight) connected to the bridge rectifier of Birrell via a transmission conductor, which is in turn connected to LEDs 59 (green box). *Id.* at 18.

According to Petitioner, the power supply, transmission conductor, and transmitter coil constitute a "first device," and the receiving coil,

transmission conductor, bridge rectifier, and LEDs constitute a "second device." *Id.* at 18, 20. Petitioner also asserts that the transmission conductor extending from the power supply of the "first device" is a "first circuit," the capacitive touch sensor of Birrell (not shown in Demonstrative A) is a "second circuit," and the receiving coil and second transmission conductor of the "second device" constitute a "third circuit." *Id.* at 18–21.

In the proposed configuration, Petitioner contends every limitation of claim 1 is taught or suggested by Birrell and Logan, including: (1) a "first device" that is composed of "the power supply, transmission conductor, and transmitter coil" and configured to wirelessly transmit power from the first device via the transmitter coil ("first inductor") (Pet. 9–18); (2) a "second device" that is composed of the receiving coil, transmission conductor, bridge rectifier, and LEDs of Birrell (*id.* at 19–20); (3) the second device having a circuit ("second circuit") that is configured to detect contact with a conductive substance via capacitive sensing for controlling at least one LED (Birrell's touch sensor with a metallized polymer film 64) (*id*); and (4) a "third circuit" that includes a conductor ("second transmission conductor") extending to the receiving coil ("second inductor") and configured to receive power wirelessly from the first device (*id.* at 20–21).

Patent Owner does not dispute that the combination of Birrell and Logan, if combined in the fashion asserted by Petitioner, teaches or suggests every limitation of claim 1. PO Resp. 17–27.

Upon review of Petitioner's arguments and the disclosures of Birrell and Logan, we find that this combination of references teaches or suggests every limitation of claim 1, for the reasons recited in the Petition.

b) Reason to Combine Birrell and Logan

Petitioner contends one of ordinary skill in the art would have sought to modify Birrell to use Logan's method of transferring power using inductive coupling for multiple reasons. First, Petitioner contends that Birrell already discloses wireless transmission of power via its capacitors, and one of ordinary skill in the art would have understood that Logan discloses a similar method of wirelessly transmitting power using an inductor. Pet. 11–12. Second, Petitioner contends that modifying Birrell to use Logan's method of using inductive coupling to provide wireless power would have been beneficial. *Id.* at 13–14. Petitioner points to Logan's disclosures that inductive coupling provides a "concentrated and localized" field, which allows lighting units to be "densely packed without interference problems." *Id.* (citing Ex. 1006, 1:6–24, 3:19–23, 6:3–11). Petitioner also asserts that one of ordinary skill in the art would have understood that inductive coupling to provide wireless power would allow for "voltage magnitude adjustments by adjusting the windings of the coils, thus providing flexibility when implementing wirelessly powering devices of different voltage requirements." *Id.* at 14 (citing Ex. 1002 ¶ 76). Petitioner also asserts that inductive coupling permits power to be transmitted across a "wide variety of panel/bulkhead materials," allowing for "improved transfer characteristics when properly configured." *Id.* (citing Ex. 1006, 4:1–5; Ex. 1012, 2:12–19, 2:31–43, 4:50–5:48, Figs. 1, 4, 5).

In addition to the specific benefits set forth above, Petitioner also contends that "there were only a handful of known techniques for transmitting power wirelessly" (inductive coupling, capacitive coupling, magnetic resonance coupling, microwave, and laser) and, therefore, the modification of Birrell to use Logan's method of inductive coupling

represents the selection of one option amongst a "finite number of identified, predictable solutions." *Id.* at 14–15 (quoting *Perfect Web Techs., Inc. v. InfoUSA, Inc.*, 587 F.3d 1324, 1331 (Fed. Cir. 2009)).

Patent Owner contends Petitioner's reasons to combine Birrell and Logan fail because (1) the Petition presents an insufficient rationale to combine the references, and (2) even if the Petition presented sufficient reasons to combine Birrell and Logan, one of ordinary skill in the art would not have sought to do so in view of "a number of problems arising from the combination." PO Resp. 17–27. We address those arguments below.

(1) Reason to Combine

(a) Versatility of Design

Petitioner notes that Logan explains that its system "can operate with a wide variety of panel/bulkhead materials," and Petitioner contends one of ordinary skill in the art would have appreciated that inductively-coupled systems/apparatus have "improved transfer characteristics when properly configured." Pet. 14. Thus, Petitioner contends that one of ordinary skill in the art would have sought to implement Logan's method of inductive power transfer because such a system "would have improved the flexibility in its design/implementation to accommodate different applications." *Id.* (citing Ex. 1006, 4:1–5; Ex. 1012, 2:31–43, 4:50–5:48, Figs. 1, 4–5; Ex. 1002 ¶ 76).

Patent Owner argues that Petitioner fails to explain how using Logan's coils in place of Birrell's capacitors "would have improved the flexibility in its design/implementation to accommodate different applications." PO Resp. 19.

Logan discloses a system capable of transmitting power and data across a panel/bulkhead and using the received power to drive one or more LEDs. Ex. 1006, code (57). Logan further discloses that there are "many

engineering situations where it would be very advantageous if power and/or data could be transmitted locally between two adjacent positions which are separated by a solid wall." *Id.* at 1:6–9. These disclosures are consistent with Petitioner's argument that the ability of Logan's apparatus to transmit power through barriers that are 100 times wider than the dielectric used in Birrell would have been advantageous, and would have allowed improved flexibility in the design of lighting systems. Pet. Reply 6–7 (citing Ex. 1005, 2:14–19; Ex. 1118 ¶ 11; Ex. 1119, 49:18–51:12; 63:7–63:11); Pet. 14.

Patent Owner's counter-argument is not persuasive. We see nothing conclusory in Petitioner's argument that having the ability to transmit power through a panel or bulkhead would expand the flexibility of Birrell's lighting applications, or even accommodate different applications. Pet. 14; Ex. 1118 ¶ 11. As such, we agree with Petitioner that one of ordinary skill in the art would have seen a versatility benefit in implementing Logan's inductive power system in Birrell's lighting apparatus.

(b) Voltage Magnitude Adjustment

As noted above, Petitioner contends the use of an inductive coil to transmit power would have been advantageous because the receiving coil could also be used to adjust the voltage provided to the LEDs. Pet. 14; Pet. Reply 7–8.

Patent Owner contends that Logan does not teach using coils to adjust voltage magnitude, and the use of Logan's coils as a transformer "would make this transmission more inefficient and would be contrary to the purpose of Logan." PO Resp. 18. Patent Owner further contends that Birrell is already optimized to drive a string of LEDs with a safe, 48 VAC power supply, and providing high voltage coils at the surface of Birrell's lighting tile "could be dangerous" and "contrary to Birrell's goal of

providing a safe system that does not present an electric shock hazard." *Id.* at 19 (citing Ex. 2001 ¶ 77; Ex. 1005, 17:34–36).

Petitioner argues in its Reply that Patent Owner is making an improper bodily-incorporation argument, and that it would have been understood that the inductor of Logan could be designed to take various forms, and with various numbers of windings, to provide the desired voltage transformation. Pet. Reply 5 (citing Ex. 1002 ¶¶ 47–48, 76, 87). Petitioner further argues that although the 48 VAC source of Birrell is optimized for a specific, 9-LED circuit arrangement, Birrell discloses that "other numbers of LED can be used." *Id.* at 7. According to Petitioner, providing the ability to adjust voltage levels to accommodate other LED designs (e.g., more/fewer LEDs) would have been a foreseeable advantage to inductive coupling. *Id.* at 7–8.

Patent Owner argues in its Sur-Reply that it would not make sense to use Logan's coils as a transformer because they "are optimized to maximize power transfer through a thick panel, not to regulate voltage," and Birrell's LED lighting system did not need voltage adjustment. Sur-Reply 7. Patent Owner further argues that there are "many places to adjust voltage other than" where the lighting element connects to the surface, and many ways to adjust voltage that do not involve transformers. *Id.* at 7–8.

Petitioner identifies a specific, demonstrable benefit to using the inductors of Logan to also act as transformers. As noted by Patent Owner, there is no express need in Birrell's primary embodiment for voltage magnitude adjustment, and there were several methods known in the art to adjust voltage that did not involve an inductor acting as a transformer. The question of motivation to combine, however, is whether one of ordinary skill in the art would have seen a benefit or reason to combine the references in

the manner set forth in the Petition. On that point, Petitioner persuasively explains that in the various embodiments of Birrell the lighting system could use differing amounts of LEDs, which would require different voltage levels. As such, Petitioner identifies a clear benefit in using an inductor, such as is disclosed in Logan, to both wirelessly transmit power and provide voltage transformation.

(c) Finite Number of Solutions

Petitioner contends that modifying Birrell to use inductive coupling as opposed to capacitive coupling would have constituted the use of known technologies, according to known methods (e.g., the use of inductors to transmit/receive wireless power) "to yield the predictable result of providing wireless power to LED lighting device(s)." Pet. 15 (citing *KSR*, 550 U.S. at 416).

Patent Owner contends "the Petition has not identified any problem where incorporating inductive coupling into Birrell would provide a solution." PO Resp. 20. According to Patent Owner, "[t]he goal of Birrell is not improved wireless power transmission, it is providing a safe, easily detachable LED lighting tile." *Id.* (citing Ex. 1005, 24:35–25:3).

KSR instructs that "[t]he combination of familiar elements according to known methods is likely to be obvious when it does no more than yield predictable results." *KSR*, 550 U.S. at 416. Here, Petitioner proposes to substitute one known method of transmitting power for another (an inductor in place of two capacitors), according to known methods (Logan), and Patent Owner does not dispute that the combination would yield a predictable result of wirelessly providing power from one device to another. This suggests that the proposed combination would have been obvious. *Id.*

Contrary to Patent Owner's counter-arguments, the Petition need not point to a specific problem discussed in Birrell for which Logan's method of using inductive coupling would be a solution. *See In re Heck*, 699 F.2d 1331, 1333 (Fed. Cir. 1983) ("The use of patents as references is not limited to what the patentees describe as their own inventions or to the problems with which they are concerned. They are part of the literature of the art, relevant for all they contain.") (internal quotations omitted). What the Petition must demonstrate is that there was some reason why one of ordinary skill in the art would have sought to combine the elements in the manner proposed. *KSR*, 550 U.S. at 418. The Petition provides multiple, persuasive reasons (discussed above) as to why one of ordinary skill in the art would have sought to use inductors, as disclosed in Logan, to wirelessly transmit power to a lighting device, such as that disclosed in Birrell.[13]

(d) Conclusion

For the reasons set forth above, we find that Petitioner presents multiple, persuasive reasons as to why one of ordinary skill in the art would have sought to implement the wireless power transmission system of Logan in the lighting device of Birrell.

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[13] As part of its motivation to combine arguments, Petitioner contends that Birrell "is configured to wirelessly transmit power from the [first] device" and, like Birrell, Logan discloses providing wireless power to an LED. Pet. 12 (citing Ex. 1002 ¶ 72). Patent Owner counters that delivering power via capacitive coupling is not a "wireless" method of power transfer. PO Resp. 20; Sur-Reply 4–6. We need not determine whether one of ordinary skill in the art would have considered the capacitive coupling in Birrell to be "wireless," because the benefits identified by Petitioner for the use of Logan's inductors do not rely exclusively on Birrell being a wireless system.

(2) Alleged Problems with the Combination

Patent Owner contends a person of ordinary skill in the art would not have looked to combine Birrell and Logan in view of "a number of problems arising from the combination." PO Resp. 21. First, Patent Owner contends the lighting tile of Birrell is thin, easily installed and moved, and "designed for a lower degree of alignment accuracy compared to prior art lighting without capacitive coupling." *Id.* at 21–22. In contrast to the thin tiles of Birrell, Patent Owner contends Logan teaches a system that uses bulky, iron-core coils that are aligned across a panel boundary to couple localized energy across the gap. *Id.* at 23.

Patent Owner contends the use of inductor coils would require significantly more precision than the use of capacitive plates in Birrell. *Id.* at 25. Patent Owner reasons that the capacitive strips of Birrell may be placed slightly off center or out of position and still provide power to tile element 50. In contrast, Patent Owner contends the inductor coils of Logan require specific alignment in order to provide a "concentrated and localized" magnetic field, and minor changes in placement "will result in much less efficiency." *Id.* at 25–26.

Patent Owner also argues that Birrell uses magnetic sheets to attach the lighting tile to the surface structure and such sheets "would not be suitable between the two coils [of Logan] as they would block the magnetic field between coils and greatly reduce efficiency." *Id.* at 26. Patent Owner further argues that coils inherently have resistance, which would cause additional heat, increase power consumption, and reduce reliability in Birrell's system. *Id.*

Patent Owner further argues that providing a high voltage coil at the surface of Birrell's light tile "could be dangerous and would be contrary to

Birrell's goal of providing a safe system that does not present an electrical hazard." *Id.* at 18–19.

Petitioner argues in Reply that one of ordinary skill in the art would have selected an inductor for use in Birrell that had minimal thickness, such as planar, spiral, or similar thin form factor loop inductors. Pet. Reply 8–9 (citing Ex. 1118 ¶¶ 12–13). Petitioner further argues that Birrell's system requires accurate alignment and that a failure to accurately align the capacitor plates would decrease efficiency. *Id.* at 10–11. Petitioner also argues that magnetic strips are only one potential way of mounting the lighting tile in Birrell, and one of ordinary skill in the art seeking to implement inductive coils in Birrell could simply use Birrell's other disclosed methods of mounting the tile, such as adhesive strips. *Id.* at. 11. Petitioner also argues that the proposed modification would not require a "high voltage coil" but, in any event, one of ordinary skill in the art knew how to minimize such hazards, such as by hermetically sealing components. *Id.* at 8. Finally, Petitioner contends that one of ordinary skill in the art implementing coils in Birrell would have known how to design such a system to maintain efficient operation, for example, by selecting appropriate "coil materials, sizes, loop designs, heat sinks, etc." *Id.* at 14 (citing Ex. 1118 ¶ 13).

In the Sur-Reply, Patent Owner repeats its arguments that Petitioner's proposed combination would use bulky, high-voltage iron-cored coils. Sur-Reply 9. Patent Owner further argues that Petitioner's evidence of thin inductors was not presented in the Petition and should not be considered now. *Id.* With respect to alignment accuracy, Patent Owner contends that Birrell's capacitive coupling allows for reasonable efficiency even if the magnets holding the lighting tile in place are not perfectly aligned, whereas

Logan's use of a concentrated magnetic field would lead to poor efficiency or even complete inoperability if the inductors are even slightly misaligned. *Id.* at 10.

As laid out above, Patent Owner presents evidence that configuring the lighting panel of Birrell to be powered wirelessly using Logan's inductors would have drawbacks, including the potential for reduced alignment flexibility, less efficient power transfer when the coils are misaligned, increased tile thickness, and increased heat generation. In demonstrating that a reason existed in the art to combine one or more references, however, Petitioner need not demonstrate that the proposed combination would be the most efficient, most practical, or most desired design, only that such a design is a known, suitable option. *Intel Corp. v. Qualcomm Inc.*, 21 F.4th 784, 800 (Fed. Cir. 2021) (holding that it is not necessary to show that a combination is the best option, only that it is a suitable option); *PAR Pharm., Inc. v. TWI Pharms, Inc.*, 773 F.3d 1186, 1197–98 (Fed. Cir. 2014) ("Our precedent, however, does not require that the motivation be the *best* option, only that it be a *suitable* option from which the prior art did not teach away."); *In re Fulton*, 391 F.3d 1195, 1200 (Fed. Cir. 2004) (holding that a particular combination need not be "the preferred, or the most desirable, combination described in the prior art in order to provide motivation"). Here, Petitioner persuasively demonstrates that using inductors to wirelessly transfer power to operate LEDs, such as the LEDs of Birrell, was a known and suitable option (and expressly disclosed in Logan) and that this option would have discrete benefits. That is sufficient to demonstrate that one of ordinary skill in the art would have sought to combine Birrell and Logan.

Moreover, Petitioner presents evidence that all of the potential drawbacks identified by Patent Owner could be managed by one of ordinary skill in the art, for example, through careful alignment of the inductor coils and selection of inductor coil designs that are consistent with use in a lighting tile.[14] Pet. Reply 9–10, 14. And even if some drawbacks remained over using capacitive coupling to power Birrell's LEDs, we find that these issues do not rise to the level of a teaching away, or serve to discredit the advantages identified by Petitioner of using wireless inductive power in Birrell. *See General Electric Co. v. Raytheon Techs. Corp.*, 983 F.3d 1334, 1351 (Fed. Cir. 2020) (noting that a "given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine").

In view of the forgoing, we determine that Petitioner persuasively explains why one of ordinary skill in the art would have combined Logan and Birrell to arrive at the subject matter of claim 1 of the '298 patent.

c) Conclusion with Respect to Claim 1

Upon review of the parties' arguments and the evidence of record, we determine that Petitioner persuasively identifies where Birrell and Logan teach or suggest every limitation of claim 1. Petitioner also provides a persuasive explanation as to why one of ordinary skill in the art would have combined Birrell and Logan to arrive at the subject matter of claim 1 with a reasonable expectation of success. Accordingly, Petitioner demonstrates by

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[14] We disagree that Petitioner's evidence that multiple types of inductor coils were known in the art constitutes a new argument. Logan discloses that iron-cored coils are preferred, but is not limited to such designs. Ex. 1006, 2:7–8. In addition, Petitioner's argument about various other potential designs is in direct response to Patent Owner's arguments that iron-cored coils would be disfavored in Birrell's lighting tile. PO Resp. 24–25.

a preponderance of the evidence that claim 1 would have been obvious over Birrell and Logan.

3. *Analysis: Claim 3*

Claim 3 depends from claim 1 and further requires that "said second device is adapted to receive power from a power supply connected to an AC mains." Ex. 1001, 27:39–41.

Petitioner contends that 110/120V AC power from the electrical grid is a commonly used and convenient way of providing power to lighting fixtures and other electronics, and that the AC voltage from AC mains "can be adjusted by using a transformer to a voltage suitable for the device to be powered." Pet. 23. Given the known advantages of AC mains, Petitioner contends one of ordinary skill in the art would have been motivated to connect AC mains to the 48V AC source of Birrell, as such a configuration "would provide a known predictable source of power typically used in the types of applications contemplated by Birrell and Logan." *Id.* (emphases omitted).

Patent Owner argues that the 48V AC power supply of Birrell is not AC mains and nothing in the reference suggests that this power supply is connected to AC mains. PO Resp. 28. Patent Owner further argues that Logan does not disclose a power supply connected to AC mains, and the 200 Hz frequency of the oscillator of Logan is not the typical AC mains frequency of 60 Hz. *Id.* As neither Logan nor Birrell expressly disclose a connection to AC mains, Patent Owner contends the Petition must rely on the knowledge of a person of ordinary skill in the art to improperly "gap-fill" a missing limitation. *Id.* at 29.

Patent Owner also argues that the power supply in Birrell operates at 48V AC so that the system "does not present an electric shock hazard to

persons or animals," and using AC mains would require redesigning the system of Birrell to operate at 120V and 60 Hz, as opposed to 48V and 80 kHz. *Id.* at 30–31.

Petitioner argues in response that use of AC mains power was known in the art and that Birrell "encompasses residential applications that were known to provide AC mains power." Pet. Reply 14–15. Petitioner further argues that Birrell is not limited to any particular voltage source or arrangement of LEDs but, in any event, conventional components would be used to provide the desired voltage, such as 48V AC, which would not be a shock hazard. *Id.* at 15–17 (asserting that any potential shock hazards could be mitigated by sealing the components, as contemplated in Birrell).

Dr. Baker persuasively testifies that, in the United States, AC main power from the electrical grid is provided at 110/120 V. Ex. 1002 ¶¶ 47, 87; Ex. 2001 ¶ 98 (Mr. Credelle testifying that "AC mains is understood to be the power received in a building, typically 110 V AC at 60 Hz in the United States"). Thus, AC mains power was well known in the art and known to be the source of power for buildings, etc. Ex. 2001 ¶ 98.

Petitioner persuasively explains that one of ordinary skill in the art would have sought to connect the AC mains power provided to a building to the 48V AC source noted in Birrell in order to provide a constant source of power. Pet. 23; Ex. 1005, 8:34–9:10. Petitioner also persuasively explains that it was known in the art that the voltage of the AC mains power could be reduced to a level suitable for the powered device, such as 48 V AC, using a transformer. *Id.*

Patent Owner's counter-arguments are not persuasive. First, Petitioner persuasively explains that Birrell's disclosure that the lighting tile is used in applications in buildings would at least suggest to one of ordinary

skill in the art that AC mains power was available. Pet. 23. Second, a missing limitation may be provided by reference to the common knowledge of an ordinarily skilled artisan. *Koninklijke Philips N.V. v. Google LLC*, 948 F.3d 1330, 1337 (Fed. Cir. 2020). Here, both declarants agree that AC mains power at 110/120V and 60 Hz was well known in the art and understood to be the standard source of power received from the electrical grid in the United States. Ex. 1002 ¶ 87; Ex. 2001 ¶ 98; PO Resp. 28 ("AC mains is understood to be the power received in a building, typically 110 V AC at 60 Hz in the United States.").

Finally, the Petition does not assert that AC mains power at 110/120 V and 60 Hz would be provided directly to the lighting tile in Birrell, as asserted by Patent Owner. PO Resp. 31. Rather, the Petition contends AC main power would be used to power the 48 V AC source powering the LEDs, and adjusted to the appropriate voltage for the apparatus using known components, such as transformers. Pet. 23.

In view of the forgoing, we determine that Petitioner demonstrates by a preponderance of the evidence that claim 3 would have been obvious over Birrell and Logan.

4. Analysis: Claim 10

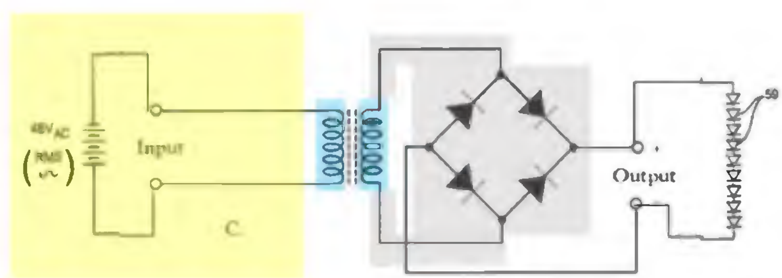
Claim 10 is independent and differs in part from independent claim 1 in requiring (1) "a power supply, wherein said power supply is configured to provide power to the apparatus and is configured to receive power wirelessly from a power source"; and (2) "a data receiver, wherein said data receiver is configured to receive data from an antenna." Ex. 1001, 28:14–22.

a) Power Supply and Power Source

Petitioner contends one of ordinary skill in the art would have sought to implement the inductive power supply configuration of Logan in Birrell

for the reasons discussed above with respect to claim 1. Pet. 27–28. With respect to the "power supply" and "power source" limitations of claim 10, Petitioner contends its proposed combination discloses them in at least two ways.

Petitioner's first mapping relies on Demonstrative D, reproduced below:



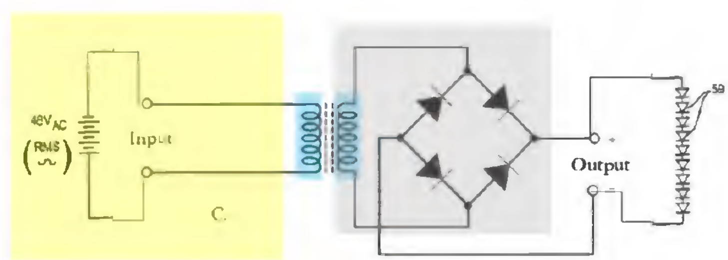
Demonstrative D

Demonstrative D shows Petitioner's proposed combination of Logan and Birrell.[15] Petitioner contends that in this configuration the rectifier formed by diodes 67 and the conductors connecting the receiving coil are the claimed "power supply," as these elements provide "power to power LEDs 59 in the 'apparatus.'" *Id.* at 28. The receiving coil is part of the "power

[15] Petitioner contends that the preamble phrase "apparatus" can be identified in the Birrell-Logan combination in two ways. First, the entire set of components shown in Demonstrative D, above, could be considered the claimed "apparatus." Pet. 25. Second, the "apparatus" could be mapped just to the right side of Demonstrative D, i.e., all the components physically or conductively connected to the receiving coil. *Id.* at 26. Petitioner contends that both mappings are consistent with the claims because the "apparatus" would be composed of every element recited in the body of the claim. *Id.* at 25–26.

source" that, in combination with the transmitting coil, delivers power to the apparatus. *Id.*

Petitioner's second mapping relies on Demonstrative E, reproduced below:



Demonstrative E

Demonstrative E is Petitioner's second proposed mapping of the combination of Logan and Birrell. Petitioner contends that in this mapping "the rectifier (diodes 67), the receiving coil, and the conductors connecting the receiving coil" are the claimed "power supply" that provides power to the LEDs of the "apparatus," and this "power supply" is configured to receive power wirelessly from a power source (e.g., the 48 V AC power source) via the transmitting coil. *Id.* at 29.

Patent Owner argues that the element in the yellow box above is expressly referred to in Birrell as a "48 Volt AC power supply," and "Birrell does not disclose a power source or that the 48 Volt AC power supply receives power wirelessly from a power source." PO Resp. 32. Rather than identify the "48 V AC power supply" as the claimed "power supply," Patent Owner contends Petitioner relabels this element as a "48 V AC power source," without providing an explanation as to why one of ordinary skill in

the art would have considered this element the claimed "power source" rather than the claimed "power supply." *Id.* at 33.

Patent Owner also argues that one of ordinary skill in the art "would not understand the bridge rectifier and conductor to be a power supply" because the rectifier simply converts alternating current to direct current. *Id.* at 33–34. *Id.* (citing Ex. 2001 ¶ 108).

Claim 10 requires a power supply that wirelessly receives power from a power source and is configured to provide power to the apparatus. Ex. 1001, 28:16–18. We discern no requirement in claim 10 or the written description of the '298 patent that the power supply generate power, only that it receive power and deliver power to the apparatus.

In Petitioner's proposed combination, the receiving coil, bridge rectifier, and the conductors connecting the coil, wirelessly receive power from a power source (48 V AC source) and provide this power to the LEDs. Thus, the components identified by Petitioner appropriately map to the disputed limitations of claim 10.

Patent Owner's counter-arguments are not persuasive. The '298 patent does not define the terms "power supply" or "power source," and claim 10 only provides the functions performed by these two elements. Petitioner persuasively explains why the components identified above act as the claimed "power supply" and "power source." And, contrary to Patent Owner's argument, there is no evidence that Birrell used the term "48V AC power supply" in the same manner as set forth in the '298 patent, or that Birrell intended to distinguish between a "power supply" and a "power source," as those terms are used in the '298 patent.

b) Antenna

Petitioner contends that the circuitry of Birrell's tile 50 is "structured so that all data is transferred by the same electrical path that is used for the electrical power transfer." Pet. 30 (quoting Ex. 1005, 23:15–21). In the proposed combination, Petitioner contends that power and data would likewise be transferred over the same electrical path using an inductive/receiving coil, which one of ordinary skill in the art would have understood to be an "antenna." *Id.* (citing Ex. 1013, 110 ("A receiving antenna converts an electromagnetic (EM) field to an alternating current (AC)")).

Patent Owner contends that Logan does not disclose an antenna, but rather "wireless transmission of power through two iron-core coils aligned across a gap." PO Resp. 36. According to Patent Owner, in 2004 one of ordinary skill in the art "would have understood a distinction between inductors that are part of a transformer and antennas." *Id.* In particular, Patent Owner contends that "antennas convert incoming RF signals, such as radio waves, to AC current," whereas Logan's coils transfer energy using induction from one circuit to another. *Id.* at 36–37 (citing Ex. 2001 ¶ 115). Patent Owner contends this understanding is consistent with the way "antenna" is used in the '298 patent, with multiple embodiments "converting radio waves to AC current." *Id.* at 37 (citing Ex. 1001, 20:17–22, 23:28–32, 24:31–37, Figs. 37, 51, 55).

Petitioner argues in its Reply that Mr. Credelle testified that an antenna "converts incoming electromagnetic fields into alternating electric currents having the same frequencies (receiving antenna)," and that the inductor system of Logan would operate in a similar fashion. Pet. Reply 19–20 (quoting Ex. 2001 ¶ 115). Petitioner further argues that Mr. Credelle

conceded that inductors are used in antenna circuits. *Id.* at 20. Petitioner further argues that there is no limiting principle that would restrict antennas to RF frequencies and, even if such a principle existed, Birrell's system could be configured to operate at RF frequencies depending on the desired application. *Id.* at 19–20.

Patent Owner argues in its Sur-Reply that Petitioner fails to engage its argument that Logan only teaches using iron-core coils to transmit power wirelessly across a thick barrier, whereas the antennas of the '298 patent are "used to transmit data, not power." Sur-Reply 19–20. Patent Owner further argues that "whether the antennas use RF signals or some other (undisclosed) frequency is not the issue," rather "the issue is that the claimed antennas are being used to receive data, not power." *Id.* at 20.

Contrary to Patent Owner's arguments, the inductor coils of Logan are intended to transmit both power and data through a panel. Ex. 1006, code (57) ("A system in which power or data is transmitted across a panel/bulkhead . . . ."), 1:3–5 ("The present invention is concerned with a means of transmitting power and/or data through a solid member, such as an instrument panel or bulkhead."), 5:18–19 ("In further applications, data can be superimposed on a carrier and transmitted through a panel."). Dr. Baker also persuasively explains that the receiving coil of Logan would be considered an antenna by one of ordinary skill in the art.[16] Ex. 1118 ¶ 19;

[16] As noted above, Patent Owner's Response asserts that antennas convert incoming RF signals, such as radio waves, to AC currents. PO Resp. 36–37. This position is not without support in the record. *See* Ex. 1013, 110 ("An *antenna* is a radio-frequency (RF) transducer."). Ultimately, however, we understand Patent Owner's argument not to be that antennas must receive RF signals, but that the "claimed antennas are being used to receive data, not power." Sur-Reply 20. In addition, the definition provided by Patent Owner

Ex. 2005, 32 (defining "antenna" as "a specialized transducer that converts incoming electromagnetic fields into alternating electric currents having the same frequencies.").

Moreover, although an antenna may be used to send or receive data in the '298 patent (Ex. 1001, 23:26–38), we are directed to no discussion in the written description of the '298 patent that the disclosed antennas are limited to sending or receiving data, as opposed to data and power.[17] Indeed, in multiple embodiments of the '298 patent an antenna is used to operate as a proximity sensor or to "provide power to" the apparatus. Ex. 1001, 20:16–36, 24:31–51 (disclosing the use of an antenna ("second transmission conductor") to change the circulation of current flow within a directional circuit, thereby sensing proximity of a person or metallic object), 28:45–47 (claiming a "second antenna" that "is used to provide power to said apparatus").

In view of the foregoing, we determine that the receiving coil of the Logan/Birrell combination is an "antenna" that provides data to a data

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does not require that an antenna receive RF signals. Ex. 2005, 32 (definition of "antenna" as "a specialized transducer that converts incoming electronic-magnetic fields into alternating electric currents having the same frequencies (*receiving antenna*)").

[17] Claim 10 requires both "a power supply" and "a data receiver." Ex. 1001, 28:16–22. In certain circumstances, the listing of claim elements separately implies that those elements are distinct components of the patented invention. *See Becton, Dickinson and Co. v. Tyco Healthcare Group, LP*, 616 F.3d 1249, 1254 (Fed. Cir. 2010). Patent Owner does not argue that claim 10 requires a separate antenna and power supply, and embodiments of the '298 patent appear to suggest that a single antenna can both receive data and act to change the current flow in a circuit. Ex. 1001, 20:16–36, 24:31–51; *See Powell v. Home Depot U.S.A., Inc.*, 663 F.3d 1221, 1231–1232 (Fed. Cir. 2011) (noting that the intrinsic evidence is to be considered in determining whether claim elements must be separate structures).

receiver. Thus, Petitioner demonstrates by a preponderance of the evidence that claim 10 would have been obvious over Logan and Birrell.

5. Analysis: Claims 4, 11–15, 17, 21, and 23

Petitioner contends the subject matter of claims 4, 11–15, 17, 21, and 23 would have been obvious over the combined disclosures of Birrell and Logan. Pet. 24–25, 31–36, 40–46.

Patent Owner contends that claim 4 would not have been obvious for the reasons set forth above with respect to claim 1. PO Resp. 31. Patent Owner further contends that claims 11 and 12 would not have been obvious for the reasons set forth above with respect to claim 10. *Id.* at 37–38. Finally, Patent Owner contends claims 13–15, 17, 21, and 23 would not have been obvious for the reasons set forth above with respect to claims 1 and 10. *Id.* at 38–39.

For the reasons set forth above with respect to claims 1 and 10, as well as after review of Petitioner's arguments with respect to claims 4, 11–15, 17, 21, and 23, we determine that Petitioner demonstrates by a preponderance of the evidence that claims 4, 11–15, 17, 21, and 23 would have been obvious over Birrell and Logan.

E. Claim 2 over Birrell, Logan, and Johnson

Petitioner contends the subject matter of claim 2 would have been obvious over the combined disclosures of Birrell, Logan, and Johnson. Pet. 46–48.

1. Johnson

Johnson discloses a "multiple battery, multiple rate automatic switching battery charger." Ex. 1007, code (57). Figure 1 of Johnson is reproduced below:

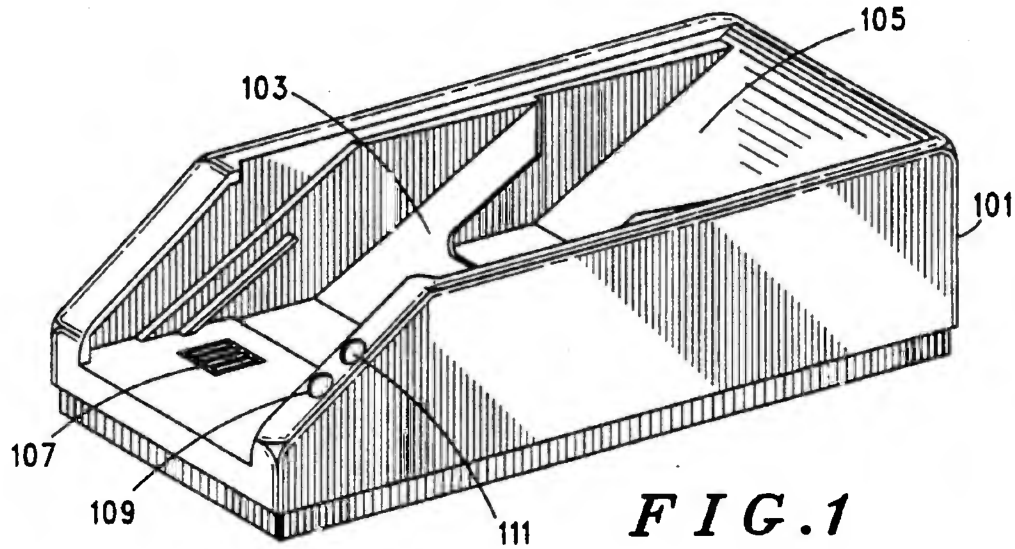

FIG.1

Figure 1 of Johnson is a perspective view of a dual pocket battery charger of the invention. *Id.* at 1:48–49. In the charger depicted in Figure 1, housing 101 "contains the electronic circuitry, microprocessor, and software necessary to charge two batteries (not shown) in a predetermined sequence." *Id.* at 1:65–67. Pockets 103 (pocket "A") and 105 (pocket "B") are located on the top surface of housing 101. *Id.* at 2:3–7. Contacts 107 allow the battery to be sensed and charged. *Id.* at 2:7–10.

Two bicolor light emitting diodes 109 and 111 are visible on a front surface of housing 101. *Id.* at 2:11–12. "LED 109 illuminates red when a battery having certain discharge characteristics" is inserted into the charger and is "undergoing fast charging." *Id.* at 2:12–15. LED 109 illuminates green when the battery is "undergoing a slow charge rate." *Id.* at 2:15–16. LED 111 illuminates red when the battery in pocket "B" is undergoing fast charging and illuminates green when undergoing slow charging. *Id.* at 2:16–19.

2. Analysis

Petitioner concedes that Birrell does not expressly disclose a first device comprising at least one colored LED, but contends one of ordinary skill in the art would have found it obvious to implement such features in view of Johnson. Pet. 46. In particular, Petitioner contends Birrell and Johnson both disclose a power delivery device and asserts that one of ordinary skill in the art would have sought to implement at least one colored LED in the "first device" of Birrell "to provide status indications of operation associated with the AC power supply." *Id.* at 47 (asserting that "a colored LED indicator would have allowed a user to quickly and efficiently determine the status of the power being delivered to tile 50").

Patent Owner contends Petitioner's arguments with respect to the combination of Birrell, Logan, and Johnson fail because "Johnson is not analogous art to the '298 Patent and combining Johnson with the system of Birrell and Logan to arrive at the claimed invention of the '298 Patent would simply be hindsight reasoning." PO Resp. 41.

To resolve whether art is analogous we must determine "(1) whether the art is from the same field of endeavor, regardless of the problem addressed and, (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved." *In re Bigio*, 381 F.3d 1320, 1325 (Fed. Cir. 2004).

Patent Owner contends Johnson is not in the same field of endeavor as the '298 patent because "Johnson is directed to a battery charger" and "[n]othing in '298 Patent Claim 2 has anything to do with batteries . . . [or] battery charging." PO Resp. 41 (citing Ex. 2001 ¶ 136). Patent Owner further contends that Johnson is not reasonably pertinent to the problem

faced by the inventors of the ’298 patent because a person of ordinary skill in the art “looking to implement different colored LED lights in the invention of the ’298 [patent] would not look to a reference directed towards charging batteries.” *Id.* (citing Ex. 2001 ¶ 138). Patent Owner reasons that the use of LEDs as charge indicators in Johnson “is a minor feature” that is “not central to the invention of Johnson,” and “[a]ny indicator—including incandescent lights, audio, haptic, or other visual indicia (text, graphical display, etc.)—could be used instead [of an LED], with similar results.” *Id.* at 41–42.

KSR instructs that “familiar items may have obvious uses beyond their primary purposes, and . . . a person of ordinary skill in the art often will be able to fit the teachings of multiple patents together like pieces of a puzzle.” *KSR*, 550 U.S. at 420. Moreover, “[w]hen a work is available in one field of endeavor, design incentives and other market forces can prompt variations of it, either in the same field or *a different one*.” *Id.* at 417 (emphasis added).

Given the guidance of *KSR*, the Federal Circuit has explained that when considering whether prior art is reasonably pertinent we must construe the scope of analogous art “broadly” and look beyond the primary problem the inventor was seeking to solve. *See Wyers v. Master Lock Co.*, 616 F.3d 1231, 1238 (Fed. Cir. 2010); *see also Donner Tech., LLC. V. Pro Stage Gear, LLC*, 979 F.3d 1353, 1360 (Fed. Cir. 2020) (explaining that the “reasonably pertinent” analysis must look to all of the problems to which the claimed invention relates, and must not be analyzed so narrowly as to effectively collapse the “field-of-endeavor and reasonable-pertinence inquiries”).

The field of endeavor of the ’298 patent includes LED lighting systems. Ex. 1001, 1:50–53. This field is broad and includes “general

lighting, signs and decoration such as Christmas tree lighting." *Id.* at 2:12–15. Johnson is a device that includes an illuminated LED. As such, Johnson is in the same field of endeavor as the '298 patent.

To the extent that Johnson is not in the same field of endeavor as the '298 patent, it is reasonable pertinent to at least one problem facing the inventors of the '298 patent. Claim 2 requires a colored LED that is part of a "first device" that is configured to transmit power to a second device. Ex. 1001, 27:22–26, 27:37–38. One of skill looking to design such a device would reasonably look to other devices in the art that are used to transmit power to another device. In addition, Petitioner persuasively explains that one problem related to power supplies is the ability to discern their operating status quickly and efficiently. Pet. 47 (citing Ex. 1002 ¶ 128). Johnson demonstrates that this problem can be solved by using colored LEDs as status indicators. *Id.* (citing Ex. 1007, 2:11–22, 6:55–60); Pet. Reply 22. Thus, Johnson is reasonably pertinent to at least one problem facing the inventors of the '298 patent, e.g., designing useful power supplies for delivering power to another device or circuit.

With respect to the reason to combine Birrell, Logan, and Johnson, both Johnson and the device of the Birrell/Logan combination have a device or circuit that is used to provide power from one element to another. In that situation, Johnson expressly teaches that LED status indicator lights are beneficial in the power supply. Ex. 1007, 1:43–45, 2:11–35. Thus, we agree with Petitioner that one of ordinary skill in the art would have seen a benefit to using a colored status indicator in the power supply of Birrell and Logan.

Patent Owner's counter-arguments are not persuasive. First, Patent Owner directs our attention to no case law suggesting that a feature must be central to a disclosed invention in order to be used in an obviousness

combination. *See* PO Resp. 41–42. Second, Patent Owner's argument that any of a number of status indicators could have been used in place of an LED indicator "with similar results," actually cuts against Patent Owner's position. As discussed in *KSR*, "when a patent claims a structure already known in the prior art that is altered by the mere substitution of one element for another known in the field, the combination must do more than yield a predictable result." *KSR*, 550 U.S. at 416; *see also id.* at 417 ("a court must ask whether the improvement is more than the predictable use of prior art elements according to their established functions."). As conceded by Patent Owner, use of LED status indicators in a power supply was known and its use was predictable, as was the use of other potential methods of indicating the status of a power supply.

In view of the foregoing, we determine that Petitioner demonstrates by a preponderance of the evidence that claim 2 would have been obvious over Birrell, Logan, and Johnson.

F. Claims 3, 10–12, and 21 over Birrell, Logan, and Zhang

Petitioner contends that the subject matter of claims 3, 10–12, and 21 would have been obvious over the combined disclosures of Birrell, Logan, and Zhang. Pet. 48–56.

1. Zhang

Zhang discloses five different LED lighting devices, including a "chip-on-board LED" exit sign. Ex. 1022 ¶ 2. The circuit board design of the chip-on-board exit sign, Figure 2.1, is reproduced below. *Id.* ¶ 83.

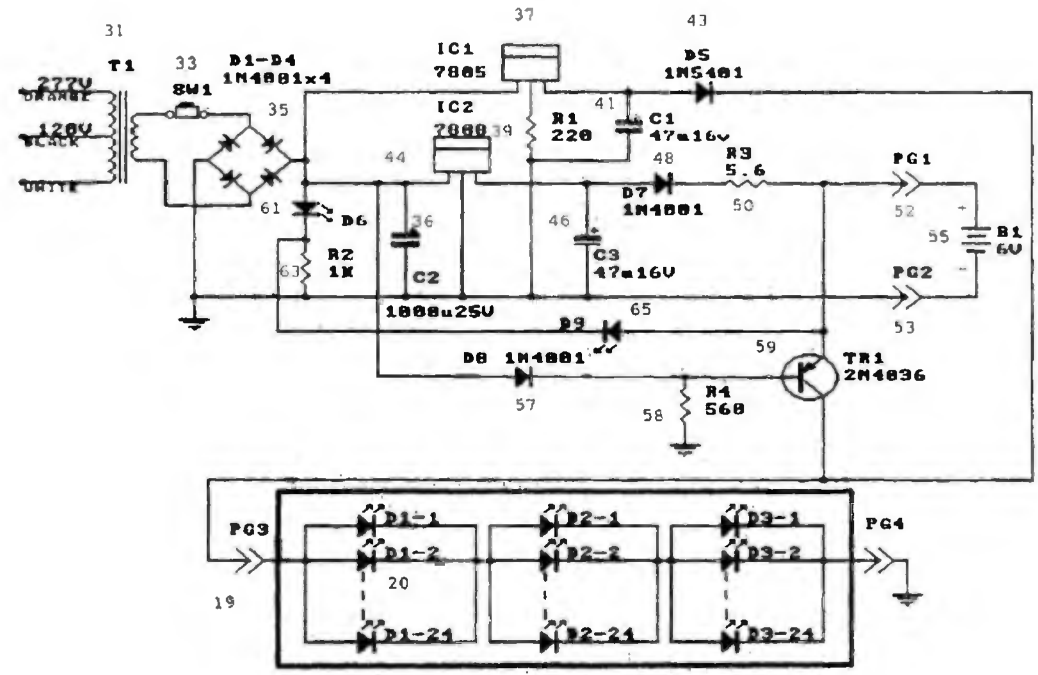

FIG. 4 <EXIT> SIGN
CIRCUIT DIAGRAM

Figure 2.1 above depicts the circuit board design of Zhang's chip-on-board exit sign. *Id.* At the top left of the figure, 120 VAC or 220 VAC power from a commercial line is reduced to 9 VAC by transformer 31 and sent to rectifier 35, which converts the 9 VAC power to DC power, which is then sent as three different outputs. *Id.* ¶¶ 83–86. The first output is used to light LEDs 19, the second output is used to charge battery 55, and the third output is used to apply a reverse positive voltage to transistor 59, preventing battery 55 from powering the LEDs. *Id.* When line power is interrupted, the transistor will become conductive and battery 55 will power LEDs 19. *Id.* ¶ 87.

2. *Analysis: Claim 3*

Claim 3 depends from independent claim 1 and further requires that "said second device is adapted to receive power from a power supply connected to an AC mains." Ex. 1001, 27:39–41.

Petitioner contends that the subject matter of claim 3 is taught or suggested by Birrell and Logan, as set forth above. Pet. 48. To the extent that adapting a second device to receive power from a power supply connected to AC mains would not have been obvious over Birrell and Logan alone, however, Petitioner contends that this limitation would also have been obvious over Birrell, Logan, and Zhang. *Id.*

Petitioner contends that Zhang discloses the limitations of claim 3 in two ways. First, Petitioner contends that Zhang expressly discloses that the 9V AC power provided to the LEDs is supplied by a 120V AC source, which one of ordinary skill in the art would have understood came from the commercial line or electrical grid, i.e., AC mains. Pet. 49–50 (citing Ex. 1022 ¶ 83; Ex. 1002 ¶ 132). Based on Zhang's disclosure, Petitioner contends one of ordinary skill in the art would have connected the 48V AC power supply of Birrell/Logan to a 120V AC commercial line, as this is a convenient way to power electronic devices. *Id.* at 50. Petitioner further contends that the 120V AC power would be adjusted using a transformer, similar to that disclosed in Zhang, to a voltage suitable for the electronic device being powered. *Id.*

Second, Petitioner contends that, for the reasons discussed below with respect to claim 21, one of ordinary skill in the art would have found it beneficial to include a rechargeable battery ("power supply") in the modified lighting tile of Birrell to provide power to the lighting tile when AC mains power is interrupted. *Id.* at 51. Petitioner asserts that this battery would have been charged by AC mains power during normal operation, such that the system "would have been adapted to receive power from a rechargeable battery (a 'power supply') that is charged by an AC mains ('a power supply connected to an AC mains')." *Id.* (citing Ex. 1002 ¶ 135).

Patent Owner contends it is not clear that Zhang's 120V AC input is referring to AC mains, but in any event Petitioner's modified system operates at 80 kHz, not the 60 Hz used by AC mains, and Petitioner does not explain how or why a person of ordinary skill in the art would have sought to convert 60 Hz AC mains to the 80 kHz signal used in Birrell. PO Resp. 44 (citing Ex. 2001 ¶ 140).

Petitioner argues in response that Birrell is not limited to use of a 48V AC supply operating at 80 kHz, but in any event one of ordinary skill would have understood how to transform AC signals to any desired frequency that was necessary for the particular application desired in the Birrell-Logan-Zhang system. Pet. Reply 24–25.

Patent Owner argues in its Sur-Reply that a 48V AC power supply is relied upon in the grounds, and it is too late to change the ground to assert that one of ordinary skill in the art would have used a different power supply. Sur-Reply 22. Patent Owner further argues that its arguments against the use of rechargeable battery in the system of Birrell are "equally applicable" and that a person of ordinary skill in the art would not have sought to use a rechargeable battery in Birrell's lighting tile for the reasons set forth below with respect to claim 10. *Id.*

On this record, we credit the testimony of Dr. Baker that one of ordinary skill in the art would have understood that the AC input of Zhang is from AC mains and that this ordinarily skilled artisan would have sought to use AC mains power—a reliable and available source of power—in Birrell, Logan, and Zhang to power the 48V AC power supply. Ex. 1002 ¶ 133. We further credit Dr. Baker's testimony that one of ordinary skill in the art would have understood how to convert this 60 Hz AC power source to any desired frequency and voltage, as determined by the specific lighting needs

of the lighting tile. *Id.*; Ex. 1118 ¶ 20. We further find, for the reasons set forth below, that one of ordinary skill in the art would have sought to use a battery backup to power the lighting tile when power is otherwise unavailable and that this backup battery would have been charged using AC mains power, as disclosed in Zhang.

Patent Owner's argument that Petitioner is seeking to switch the power source relied upon in the Petition is not persuasive. The Petition asserts that one of ordinary skill in the would have sought "to connect the 48V AC power supply (similar to as described in *Birrell*) to a 120V AC commercial line that draws power from the electrical grid." Pet. 50. The Petition also states that the AC voltage can be adjusted "to a voltage suitable for the electronic device to be powered." *Id.* These assertions demonstrate that, contrary to Patent Owner's assertions, the Petition was not relying on Birrell's specific 48V AC power supply operating at 80 kHz, but to the power source ultimately selected to power the lighting tile of the Birrell, Logan, Zhang device.

In view of the foregoing, Petitioner demonstrates by a preponderance of the evidence that claim 3 would have been obvious over Birrell, Logan, and Zhang.

3. Analysis: Claim 10

Petitioner contends that the combination of Birrell, Logan, and Zhang teaches or suggests every limitation of claim 10. In particular, Petitioner contends that one of ordinary skill in the art would have sought to implement a rechargeable battery in Birrell and Logan in view of Zhang, and would have sought to wirelessly recharge this battery using AC mains power. Pet. 54.

Patent Owner contends Petitioner's argument that Zhang's battery should be added to the Birrell-Logan circuit as a power supply fails because the proposed Birrell-Logan circuit "already has a 48V AC power supply." PO Resp. 45. Patent Owner further contends that batteries are not typically used in a lighting fixture for a house or building, and adding the battery of Zhang would "add additional size and expense to the . . . tile of Birrell," as well as require additional circuitry to switch from the 48V AC input to battery power. *Id.* Patent Owner further argues that Zhang does not teach wireless charging of its battery. *Id.* (citing Ex. 2001 ¶ 144).

Petitioner argues in reply that the battery of Zhang would beneficially provide backup power when the AC mains power source is unavailable, as expressly noted in Zhang, and the 48V AC source would still be used as needed to provide power to the apparatus. Pet. Reply 26. Petitioner further argues that the limited tradeoffs identified by Patent Owner would not deter one of ordinary skill in the art from seeking to enhance the modified system of Birrell-Logan with the teachings of Zhang. *Id.*

Patent Owner responds that Petitioner provides no support for the assertion that one of ordinary skill in the art would have sought to use a backup battery even when this results in additional size or expense. Sur-Reply 23. Patent Owner further argues that backup batteries are typically only used in "systems like smoke alarms where the primary goal is safety in an emergency," as only a minimum amount of light, such as that provided by a flashlight or window, would be necessary in case of an emergency. *Id.* Patent Owner further argues that any battery added to Birrell would need to be much larger than those used in a flashlight, further increasing the thickness and weight of Birrell's tile. *Id.* Finally, Patent

Owner argues that neither Birrell, Logan, nor Zhang discloses wireless charging. *Id.* at 24.

Zhang expressly discloses using a backup battery in an LED lighting system, and Dr. Baker persuasively explains why such a backup would be useful in the Birrell-Logan-Zhang lighting tile in emergency situations, such as during fires or earthquakes. Ex. 1002 ¶ 139; Ex. 1022 ¶¶ 83, 87. Thus, we find Petitioner's arguments persuasive as to why one of ordinary skill in the art would have sought to add Zhang's rechargeable battery to the Birrell-Logan device, e.g., to provide power in emergency situations.

Patent Owner's counter-arguments are not persuasive. First, although other forms of lighting, such as flashlights or windows could provide sufficient lighting in some circumstances, we are persuaded that a fully illuminated lighting tile would have been beneficial during an emergency, as asserted by Dr. Baker. Ex. 1002 ¶ 139.

Second, Zhang and Logan both disclose the use of a pair of inductors (forming a transformer) to transfer power wirelessly. Ex. 1006, 2:1–9; Ex. 1022 ¶ 83, Fig. 2.1. The wirelessly-received power of Zhang is then used, among other things, to charge a backup battery. Ex. 1022 ¶ 85. Thus, Patent Owner's argument that Zhang does not disclose wirelessly charging a battery is not persuasive.

Third, although use of a battery would require additional circuitry, etc., Zhang expressly discloses how this could be successfully accomplished in an LED lighting system. Ex. 1022, Fig. 2.1. Moreover, most combinations of elements from prior art references would require adaptive modifications or addition of circuitry, but such costs and additional efforts do not necessarily counsel against a beneficial combination, unless they present a significant technical challenge or would teach away from the

combination. *See Orthopedic Equip. Co. v. U.S.*, 702 F.2d 1005, 1013 (Fed. Cir. 1983) (finding a combination of references is not non-obvious simply because the references "would not be combined by business men for economic reasons"). Here, one of ordinary skill in the art would have seen a clear benefit to using a backup battery power supply in the Birrell-Logan-Zhang lighting tile, and the increased size and cost resulting from the use of a battery backup would not have taught away from or otherwise discouraged the proposed combination, as noted by Dr. Baker, especially in view of the safety improvements stemming from the combination. Ex. 1002 ¶¶ 139–140.

In view of the foregoing, Petitioner demonstrates by a preponderance of the evidence that claim 10 would have been obvious over Birrell, Logan, and Zhang.

4. Claims 11 and 12

Claim 11 depends from claim 10 and further requires that "said circuit is configured to detect contact with the conductive substance via capacitive sensing." Ex. 1001, 28:23–25. Claim 12 also depends from claim 10 and further requires that "said apparatus is configured to receive power from an AC mains power supply." *Id.* at 28:26–28.

Petitioner contends the subject matter of claim 11 would have been obvious over Birrell, Logan, and Zhang for the same reasons discussed above with respect to claim 1(c)(2) and 11. Pet. 19–20, 31, 54. With respect to claim 12, Petitioner contends this claim would have been obvious for the reasons discussed above with respect to claims 3, 10, and 21. *Id.* at 55–56.

Patent Owner contends claims 11 and 12 are patentable for the same reasons identified for claims 3 and 10. PO Resp. 46.

For the reasons set forth above with respect to claims 1(c), 2, 3, 10, 11, and 21 (see below), we determine that Petitioner demonstrates by a preponderance of the evidence that claims 11 and 12 would have been obvious over Birrell, Logan, and Zhang.

5. Claim 21

Petitioner contends the subject matter of claim 21 would have been obvious in view of Birrell, Logan, and Zhang. Pet. 51–53. In particular, to the extent it is determined that Birrell and Logan do not teach or suggest a "first device" that includes "at least one battery," Petitioner contends it would have been obvious to implement a battery in the Birrell-Logan lighting device in view of Zhang. Pet. 51. Petitioner's justifications for this modification generally follow its arguments above with respect to claim 10. *Id.* at 52–53.

Patent Owner contends claim 21 would not have been obvious over Birrell, Logan, and Zhang for the reasons discussed above with respect to claims 1, 3, 10, and 21 (Birrell-Logan). PO Resp. 39, 46–47.

For the reasons set forth above with respect to claims 1, 3, 10, and 21, as well as upon review of Petitioner's arguments with respect to claim 21 in view of Birrell, Logan, and Zhang, we determine that Petitioner demonstrates by a preponderance of the evidence that claim 21 would have been obvious over Birrell, Logan, and Zhang.

G. Claim 5 over Birrell, Logan, and Sembhi

Claim 5 depends from claim 1 and further requires "a three-way switch." Ex. 1001, 27:44–45. Petitioner contends that the subject matter of claim 5 would have been obvious over the combined disclosures of Birrell, Logan, and Sembhi. Pet. 56–57.

Sembhi discloses "[a] lighting control device for controlling the light intensity level of a[t] least one lamp." Ex. 1008, code (57). Both parties agree that, in some embodiments, "Sembhi discusses that it was known to use a three-way switch" in LED lighting applications. PO Resp. 48; Pet. 56. Petitioner also persuasively demonstrates that Sembhi teaches or suggests that a three-way switch is advantageous because it allows a user to control the lighting device from multiple locations. Pet. 56–57 (citing Ex. 1002 ¶ 149; Ex. 1008 ¶ 18).

Given the express disclosures of Sembhi, as well as the fact that three-way switches were well known in the art for controlling LED lighting systems, Petitioner contends one of ordinary skill in the art would have sought to implement a three-way switch in the lighting device of Birrell and Logan. *Id.* at 57.

Patent Owner contends claim 5 would not have been obvious over the combined disclosures of Birrell, Logan, and Sembhi because claim 1, from which claim 5 depends, would not have been obvious over Birrell and Logan. PO Resp. 49.

Upon review of the record, as well as for the reasons set forth above for claim 1, we determine that Petitioner demonstrates that Birrell, Logan, and Sembhi teach or suggest every limitation of claim 5. Petitioner also provides a reasoned explanation, supported by record evidence, to explain why one of ordinary skill in the art would have combined these references to arrive at the subject matter of claim 5 with a reasonable expectation of success. Accordingly, Petitioner demonstrates by a preponderance of the evidence that claim 5 would have been obvious over Birrell, Logan, and Sembhi.

H. Claims 6 and 24 as Anticipated by Birrell

Petitioner contends claims 6 and 24 are anticipated by Birrell.[18] Pet. 58–61.

1. Analysis: Claim 6

Claim 6 is independent and requires "A method of operating an apparatus, the method comprising:" (1) receiving power wirelessly in the apparatus; (2) transmitting or receiving data signals wirelessly; (3) detecting contact with a conductive substance via capacitive sensing; and (4) increasing the level of power to an LED circuit comprising at least one LED in the apparatus after detection of the contact. Ex. 1001, 27:46–54.

There is no dispute that Birrell expressly discloses transmitting or receiving data signals wirelessly (Pet. 58–59), detecting contact with a conductive substance via capacitive sensing (*id.* at 59), and increasing the level of power to an LED circuit after detection of the contact (*id.*). The parties' dispute centers around whether Birrell discloses receiving power wirelessly in the apparatus. Pet. 58; PO Resp. 49–50; Pet. Reply 27–28; Sur-Reply 24–27.

In Birrell's primary embodiment, an AC power supply is capacitively coupled to tile 50 and transmits power to LEDs 59 via capacitors C_A and C_B. Ex. 1005, 2:36–3:16, 3:17–27, Fig. 8. Birrell explains that one "particular advantage" of this method of using capacitive coupling to power the LEDs "is that the device may be coupled to the power source without requiring any direct connection between the respective conductive elements of the device and the supporting surface." *Id.* at 3:17–21. Petitioner contends the fact that

[18] Petitioner originally challenged claims 6, 18, and 24 as anticipated by Birrell. As noted previously, Patent Owner subsequently disclaimed claim 18.

there is no direct connection between the capacitor plates of Birrell demonstrates that power is received wirelessly in the lighting tile of Birrell. Pet. 58; Pet. Reply 27–28.

Patent Owner argues that Birrell does not describe its capacitive coupling as wireless, and "[t]he fact that all capacitors have some space between their plates does not mean that every circuit using a capacitor is wireless." PO Resp. 49; Ex. 2001 ¶ 80 (Mr. Credelle testifying that one of ordinary skill in the art would not understand "the mere use of capacitors in a circuit to imply wireless power transmission").

Petitioner argues in its Reply that Birrell's method of transmitting power and data between physically separated elements constitutes wireless transmission of power. Pet. Reply 27–28. In support of this argument, Petitioner provides numerous citations to prior art patents that describe the use of capacitive coupling as a wireless power transfer method. *Id.* at 28 (citing Exs. 1118, 1126, 1131, 1132, 1133, 1134).

Patent Owner argues in its Sur-Reply that "the most relevant source of what Birrell means *is* Birrell," and Birrell does not describe its method as one related to wireless power transfer. Sur-Reply 25–26. Instead, Patent Owner contends Birrell only uses the term "wireless" once, and that is with respect to data communication using RF signals. *Id.* at 25.

By its express language, the claim term "wirelessly" is best understood as "without the use of a wire." We are directed to no disclosure in the written description or prosecution history that would contradict this conclusion or otherwise shed light on the meaning of this claim term.

There is no dispute that capacitive coupling does not use a wire or any other form of direct contact to transmit power. Thus, the plain meaning of "wirelessly" encompasses capacitive coupling. This conclusion is supported

by the patents provided by Petitioner. For example, U.S. Patent No. 6,336,031 states that "[c]onnectionless (i.e., wireless) transmission of analog and digital signals has previously been accomplished using . . . [c]apacitive coupling." Ex. 1131, 1:10–18. Likewise, U.S. Patent No. 6,988,026 describes a "power receiving system which receive[s] power wirelessly (inductively, through radio frequency energy transfer and/or capacitively)." Ex. 1133, 113:64–114:2.

Mr. Credelle's counter-testimony is not persuasive because he does not explain in any detail why one of ordinary skill in the art would not understand a capacitive coupling that transfers power to be a wireless system. *See* Ex. 2001 ¶ 80.

Upon review of the prior art as a whole, as well as the parties' arguments and evidence, we determine that Petitioner identifies where Birrell discloses every limitation of claim 6. Accordingly, claim 6 is anticipated by Birrell.

2. Claim 24

Claim 24 depends from claim 6 and further requires that "the conductive substance includes a metallic material." Ex. 1001, 29:27–28.

Petitioner contends claim 24 is anticipated by Birrell's disclosure that the conductive substance that acts as a touch sensor is a "metallised polymer film." Pet. 43 (citing Ex. 1005, 16:18–26).

Patent Owner contends claim 24 is not anticipated by Birrell for the same reasons discussed above with respect to claim 6. PO Resp. 50.

Upon review of Birrell and the parties' arguments as a whole, we determine that Petitioner demonstrates that Birrell discloses every limitation of claim 24. Accordingly, Petitioner demonstrates by a preponderance of the evidence that claim 24 is anticipated by Birrell.

I. Claims 7, 8, and 25 over Birrell, Logan, and Camras

Petitioner contends that the subject matter of claims 7, 8, and 25 would have been obvious over the combined disclosures of Birrell, Logan, and Camras. Pet. 50–52. In support, Petitioner identifies where these references teach or suggest every limitation of claims 7, 8, and 25, and provides a persuasive explanation as to why the three references would have been combined to arrive at the subject matter of the three claims. *Id.*

Patent Owner contends claims 7, 8, and 25 would not have been obvious over Birrell, Logan, and Camras for the same reasons set forth above with respect to claims 1, 7, and 10. PO Resp. 50–52.

Upon review of Petitioner's arguments, as well as the parties' arguments with respect to claim 1, 7, and 10, we determine that Petitioner demonstrates by a preponderance of the evidence that claims 7, 8, and 25 would have been obvious over Birrell, Logan, and Camras.

J. Claim 9 over Birrell, Logan, and Gleener

Claim 9 is similar to claims 1 and 10, but further requires "a capacitor coupled to the antenna" that is "configured to tune the antenna." Ex. 1001, 28:8–9. Petitioner contends the subject matter of claim 9 would have been obvious over the combined disclosures of Birrell, Logan, and Gleener. Pet. 65–71. In support, Petitioner identifies where these references teach or suggest every limitation of claim 9, including a capacitor that is coupled to an antenna and configured to tune it (Gleener). *Id.* at 67–68.

Patent Owner contends claim 9 would not have been obvious for the same reasons discussed above with respect to claims 1 and 10. PO Resp. 53–54. In particular, Patent Owner contends that "neither Birrell nor Logan teaches the claimed antenna, and a [person of ordinary skill in the art] would

not look to combine Logan's coils into the capacitive coupling system of Birrell." *Id.* at 54.

Upon review of the parties' arguments, and for the reasons set forth above with respect to claims 1 and 10, we determine that Petitioner demonstrates by a preponderance of the evidence that claim 9 would have been obvious over Birrell, Logan, and Gleener.

K. Claim 16 over Birrell, Logan, and Rahmel

Claim 16 is independent and is similar to claims 1 and 10, but further requires "a second antenna configured to receive radio frequency noise, wherein said radio frequency noise is used to provide power to said apparatus." Ex. 1001, 28:41–51. Petitioner contends that the subject matter of claim 16 would have been obvious over the combined disclosures of Birrell, Logan, and Rahmel. In particular, Petitioner contends that Rahmel discloses using an "energy reclamation system (ERS) antenna to receive ambient RF noise and convert the same to power a device and/or charge a battery therein." Pet. 72 (citing Ex. 1011, 1:52–2:20, Fig. 7). Petitioner further contends that one of ordinary skill in the art would have understood that the ability to collect and store energy via an ERS antenna would be beneficial in the lighting system of Birrell and Logan. *Id.* at 73.

Patent Owner contends claim 16 is not obvious for the same reasons discussed above with respect to claims 10 and 17 (Birrell-Logan). PO Resp. 55.

Upon review of the prior art of record, Petitioner's arguments with respect to Rahmel, and for the reasons set forth above with respect to claims 10 and 17, we determine that Petitioner demonstrates by a preponderance of the evidence that claim 16 would have been obvious over Birrell, Logan, and Rahmel.

L. Claim 22 over Birrell, Logan, and Sontag

Claim 22 is independent and generally contains the same limitations as claims 1, 4, 21, but further requires a "transmit device" that is "configured to transmit power and signals wirelessly to the data communications device using resonance and inductance." Ex. 1001, 29:15–24; Pet. 75–78. Petitioner contends Sontag discloses a system that is configured to transmit both power and data wirelessly using an antenna that "consists of a resonant LC circuit" that includes an inductor and capacitor. Pet. 76 (citing Ex. 1012, 3:2–13, Figs. 1–3). Thus, Petitioner contends Sontag discloses the unique limitations of claim 22. *Id.* at 76–77.

Petitioner contends one of ordinary skill in the art would have sought to use Sontag's resonant LC circuit in the device of Birrell and Logan because it was understood in the art that such a circuit would improve "transfer characteristics" of a receiving antenna, such as the antenna of tile 50 of Birrell. *Id.* at 77.

Patent Owner contends claim 22 would not have been obvious over Birrell, Logan, and Sontag for the reasons discussed above with respect to claim 1 (Birrell and Logan). PO Resp. 57.

Upon review of the prior art of record, as well as the parties' arguments with respect to claim 1, we determine that Petitioner demonstrates by a preponderance of the evidence that claim 22 would have been obvious over Birrell, Logan, and Sontag.

III. CONCLUSION[19]

In summary:

Claim(s)[20]	35 U.S.C. §	Reference(s)/Basis	Claims Shown Unpatentable	Claims Not Shown Unpatentable
1, 3, 4, 10–15, 17, 21, 23	103	Birrell, Logan	1, 3, 4, 10–15, 17, 21, 23	
2	103	Birrell, Logan, Johnson	2	
3, 10–12, 21	103	Birrell, Logan, Zhang	3, 10–12, 21	
5	103	Birrell, Logan, Sembhi	5	
6, 24	102	Birrell	6, 24	
7, 8, 25	103	Birrell, Logan, Camras	7, 8, 25	
9	103	Birrell, Logan, Gleener	9	
16	103	Birrell, Logan, Rahmel	16	
22	103	Birrell, Logan, Sontag	22	
		Overall Outcome	1–17, 21–25	

[19] Should Patent Owner wish to pursue amendment of the challenged claims in a reissue or reexamination proceeding subsequent to the issuance of this decision, we draw Patent Owner's attention to the April 2019 *Notice Regarding Options for Amendments by Patent Owner Through Reissue or Reexamination During a Pending AIA Trial Proceeding*. *See* 84 Fed. Reg. 16,654 (Apr. 22, 2019). If Patent Owner chooses to file a reissue application or a request for reexamination of the challenged patent, we remind Patent Owner of its continuing obligation to notify the Board of any such related matters in updated mandatory notices. *See* 37 C.F.R. § 42.8(a)(3), (b)(2).
[20] As discussed above, Patent Owner disclaimed claims 18–20. Thus, we do not include those claims in the summary.

VI. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that claims 1–17 and 21–25 of the ’298 patent are unpatentable; and

FURTHER ORDERED that, because this is a Final Written Decision, parties to the proceeding seeking judicial review of the decision must comply with the notice and service requirements of 37 C.F.R. § 90.2.

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US010966298B2

(12) **United States Patent**
Miskin et al.

(10) **Patent No.: US 10,966,298 B2**
(45) **Date of Patent: Mar. 30, 2021**

(54) **AC LIGHT EMITTING DIODE AND AC LED DRIVE METHODS AND APPARATUS**

(71) Applicant: **Lynk Labs, Inc.**, Elgin, IL (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **16/866,119**

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Related U.S. Application Data

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(Continued)

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(52) **U.S. Cl.**

CPC ***H05B 45/37*** (2020.01); ***H05B 45/10*** (2020.01); ***H05B 45/40*** (2020.01); ***H05B 45/50*** (2020.01); *Y02B 20/30* (2013.01)

(58) **Field of Classification Search**

CPC H05B 45/37; H05B 45/40; H05B 45/10; H05B 45/50; H05B 45/42; H05B 45/00; H05B 45/60; H05B 45/39

See application file for complete search history.

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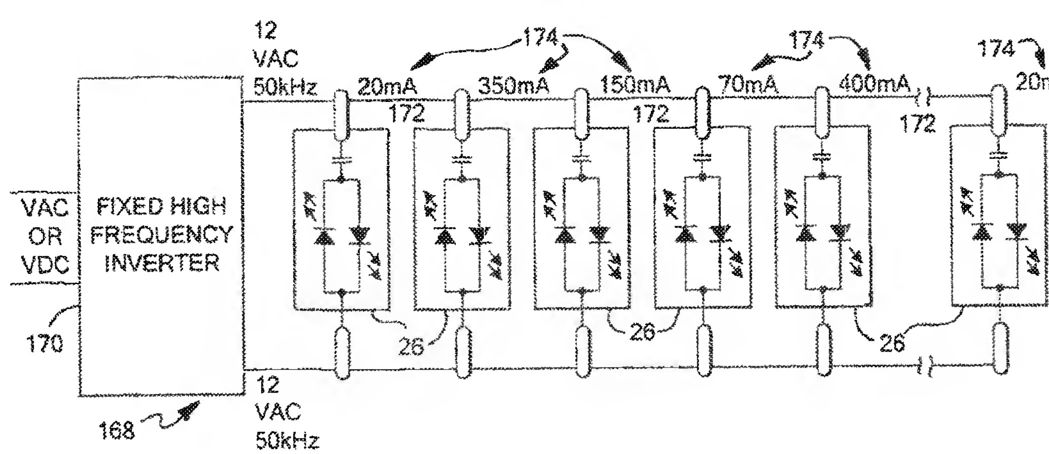
(57) **ABSTRACT**

An LED device for use with an AC voltage power source configured such that at least one LED emits light during a positive phase of power provided from an AC power supply and at least one LED emits light during the negative phase of power provided from an AC power supply. The LED device includes a first power connection lead and a second power connection lead, both leads capable of being connected to and receiving power from an AC power supply.

25 Claims, 48 Drawing Sheets



Related U.S. Application Data

May 8, 2019, now Pat. No. 10,492,252, which is a continuation of application No. 16/148,945, filed on Oct. 1, 2018, now Pat. No. 10,492,251, which is a continuation of application No. 15/334,029, filed on Oct. 25, 2016, now Pat. No. 10,091,842, which is a continuation-in-part of application No. 14/948,635, filed on Nov. 23, 2015, now Pat. No. 9,615,420, which is a division of application No. 13/697,646, filed as application No. PCT/US2011/036359 on May 12, 2011, now Pat. No. 9,198,237, and a continuation-in-part of application No. PCT/US2010/062235, filed on Dec. 28, 2010, and a continuation-in-part of application No. 12/287,267, filed on Oct. 6, 2008, now Pat. No. 8,179,055, which is a continuation-in-part of application No. 12/364,890, filed on Feb. 3, 2009, now Pat. No. 8,148,905, which is a continuation of application No. 11/066,414, filed on Feb. 25, 2005, now Pat. No. 7,489,086, which is a continuation-in-part of application No. PCT/US2010/001597, filed on May 28, 2010, which is a continuation-in-part of application No. 12/287,267, which is a continuation-in-part of application No. PCT/US2010/001269, filed on Apr. 30, 2010, which is a continuation-in-part of application No. 12/287,267, filed on Oct. 6, 2008, now Pat. No. 8,179,055.

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FIG. 1

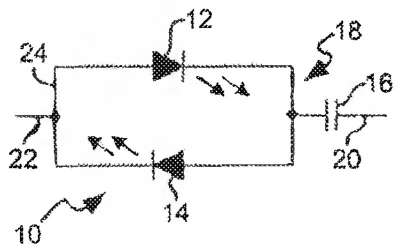


FIG. 2

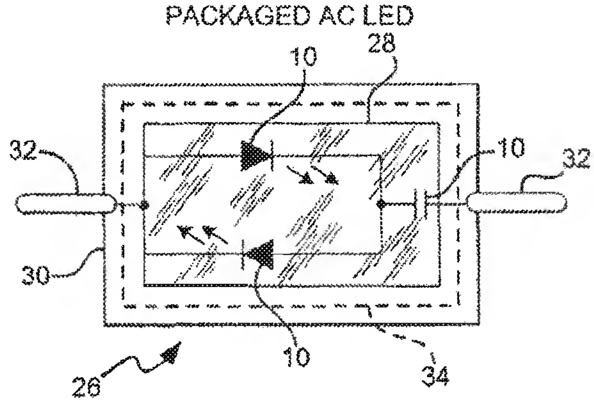


FIG. 3

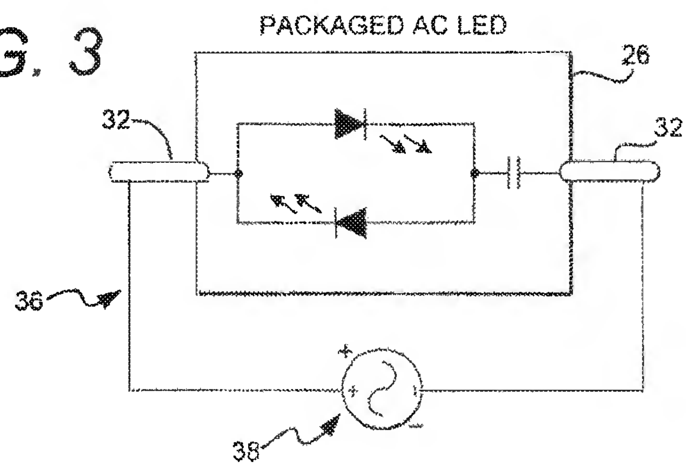


FIG. 4

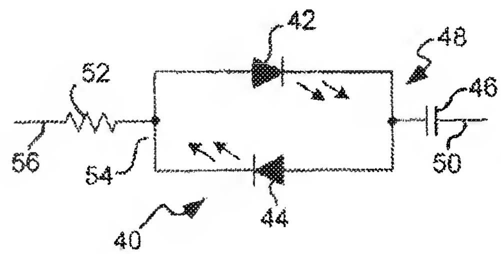


FIG. 5

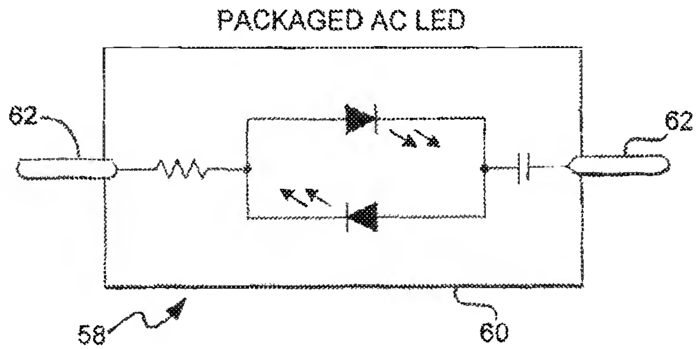


FIG. 6

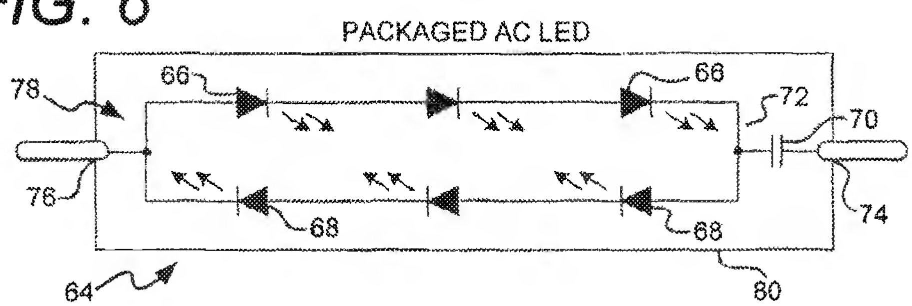


FIG. 7

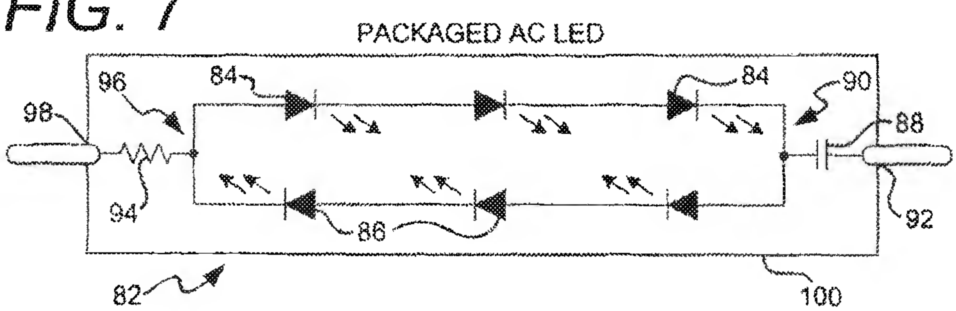


FIG. 8

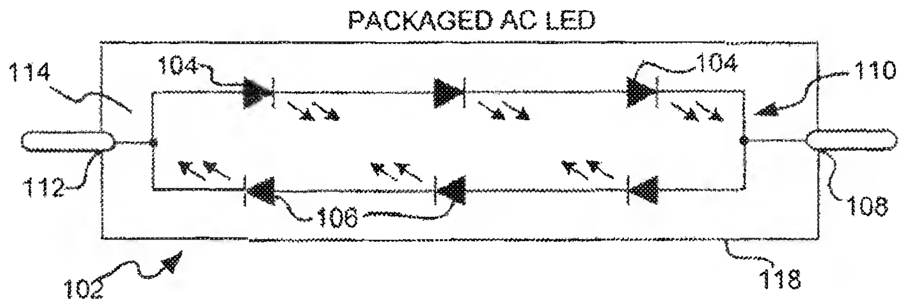


FIG. 9

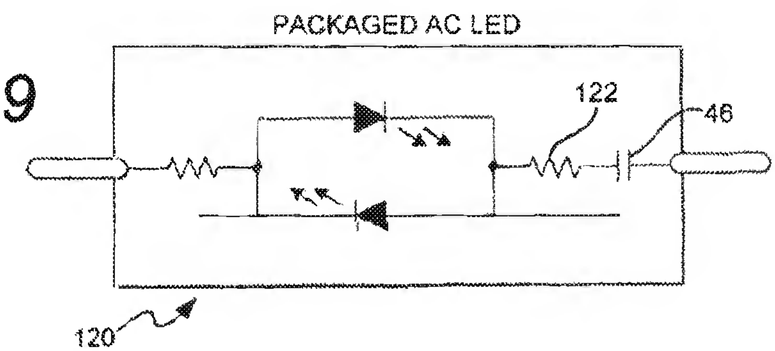


FIG. 10

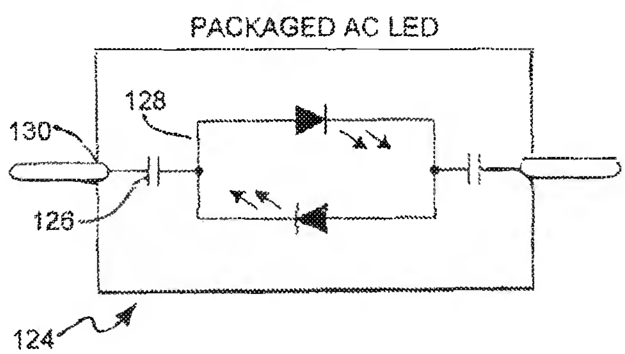


FIG. 11

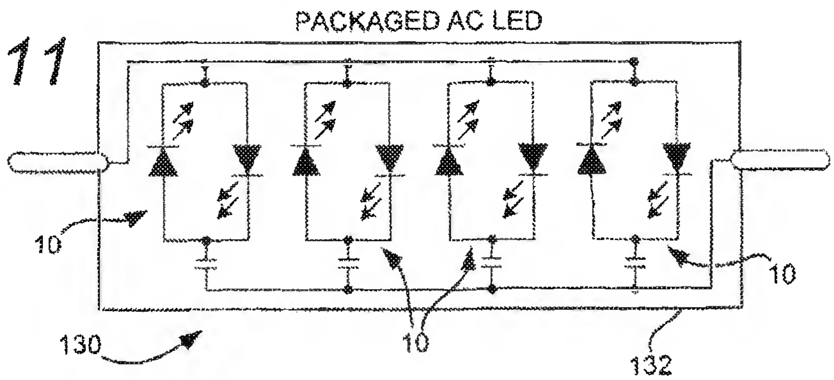


FIG. 12

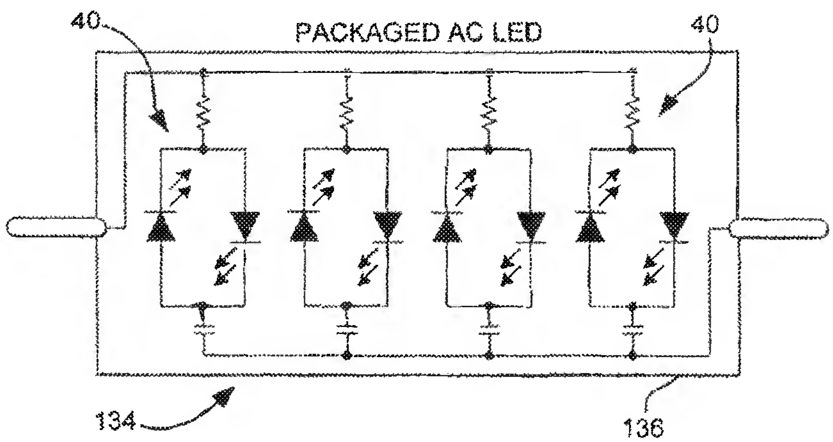


FIG. 13

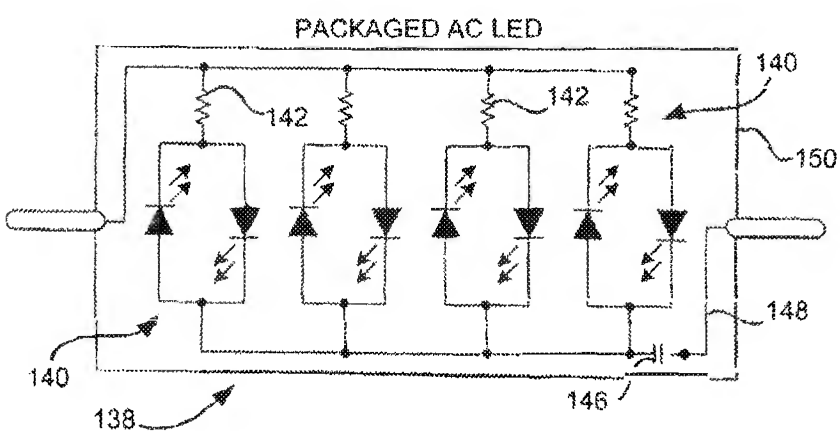


FIG. 14

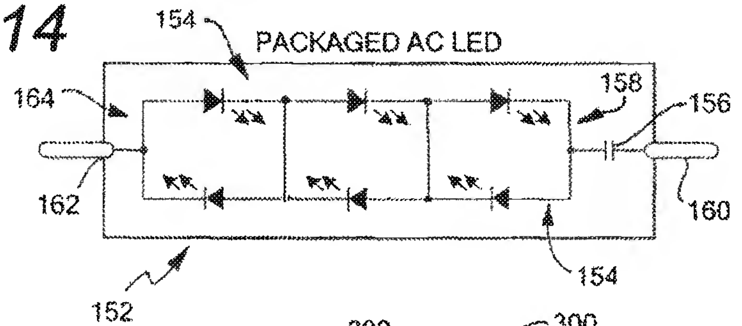


FIG. 15

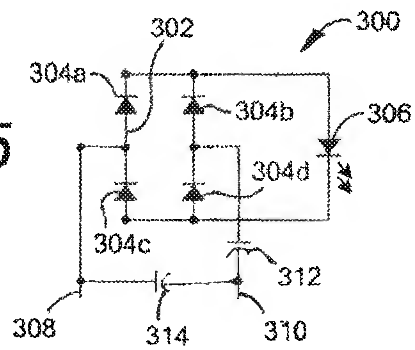


FIG. 16

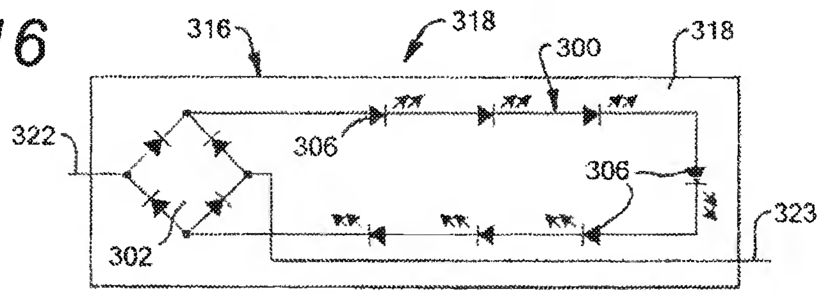
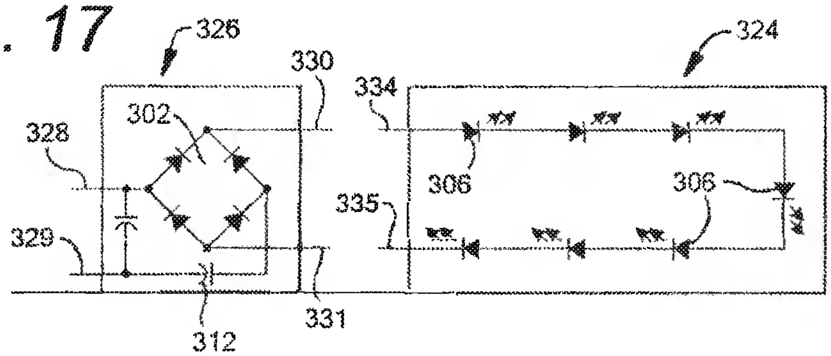


FIG. 17



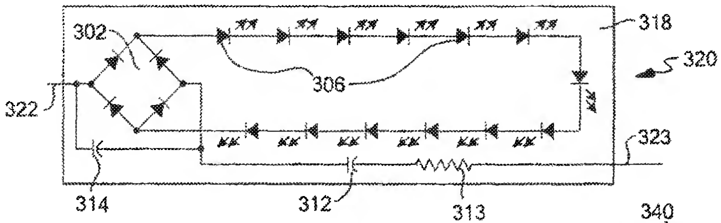


FIG. 18

FIG. 19

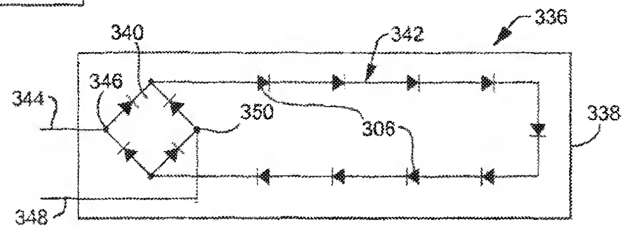


FIG. 20

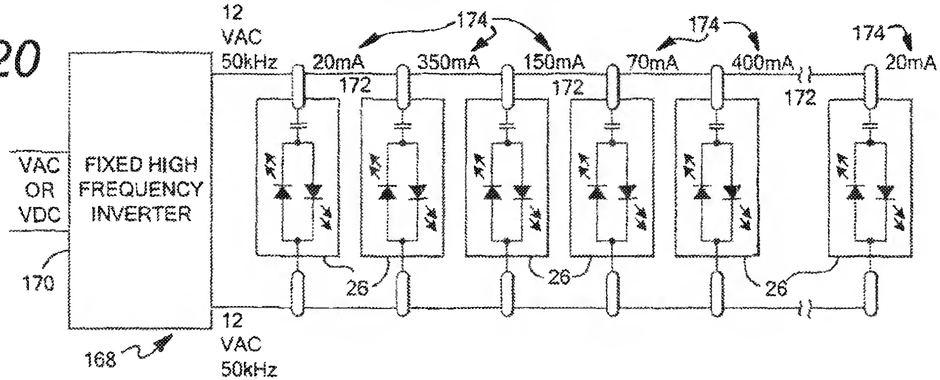


FIG. 21

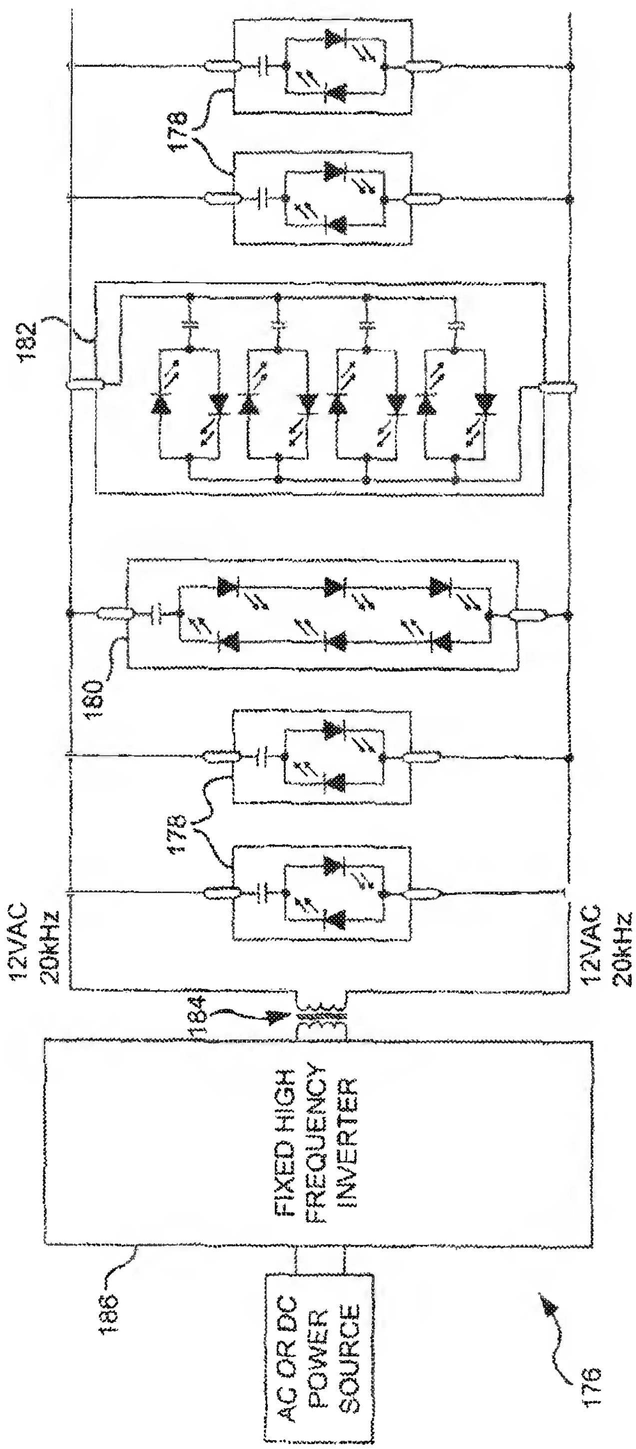
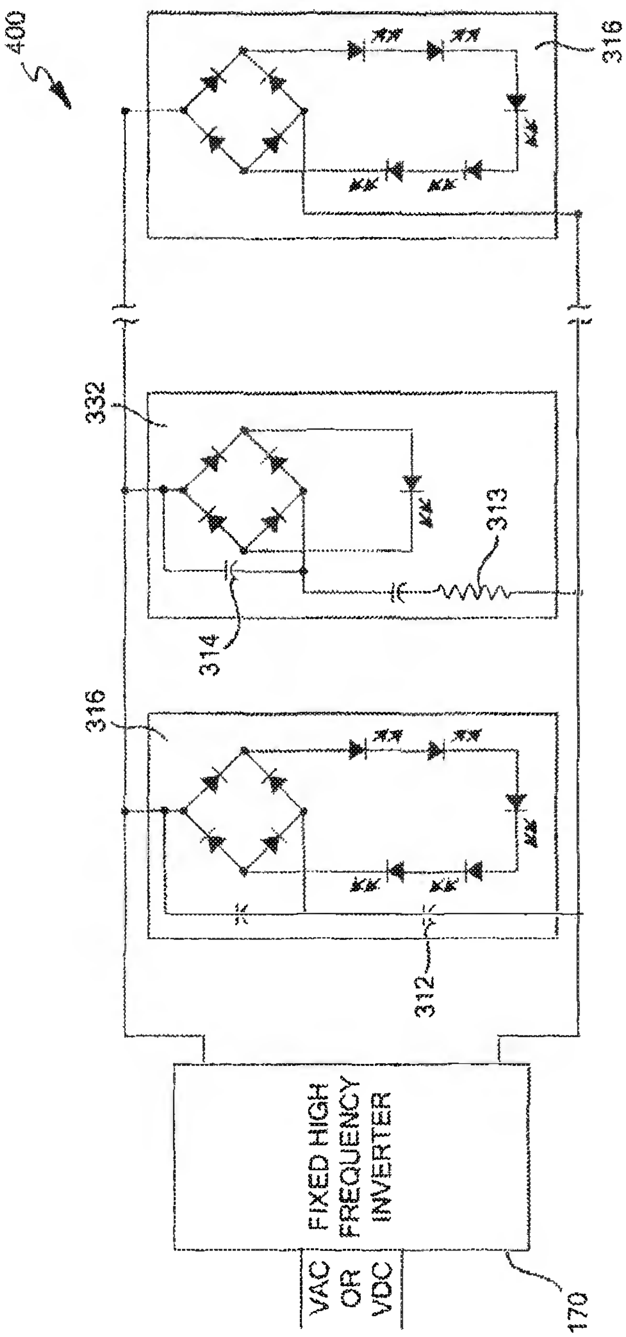

178
182
180
178
12VAC
20kHz
12VAC
20kHz
184
FIXED HIGH
FREQUENCY
INVERTER
186
AC OR DC
POWER
SOURCE
176

FIG. 22


400
316
332
313
314
316
312
FIXED HIGH FREQUENCY INVERTER
VAC OR VDC
170

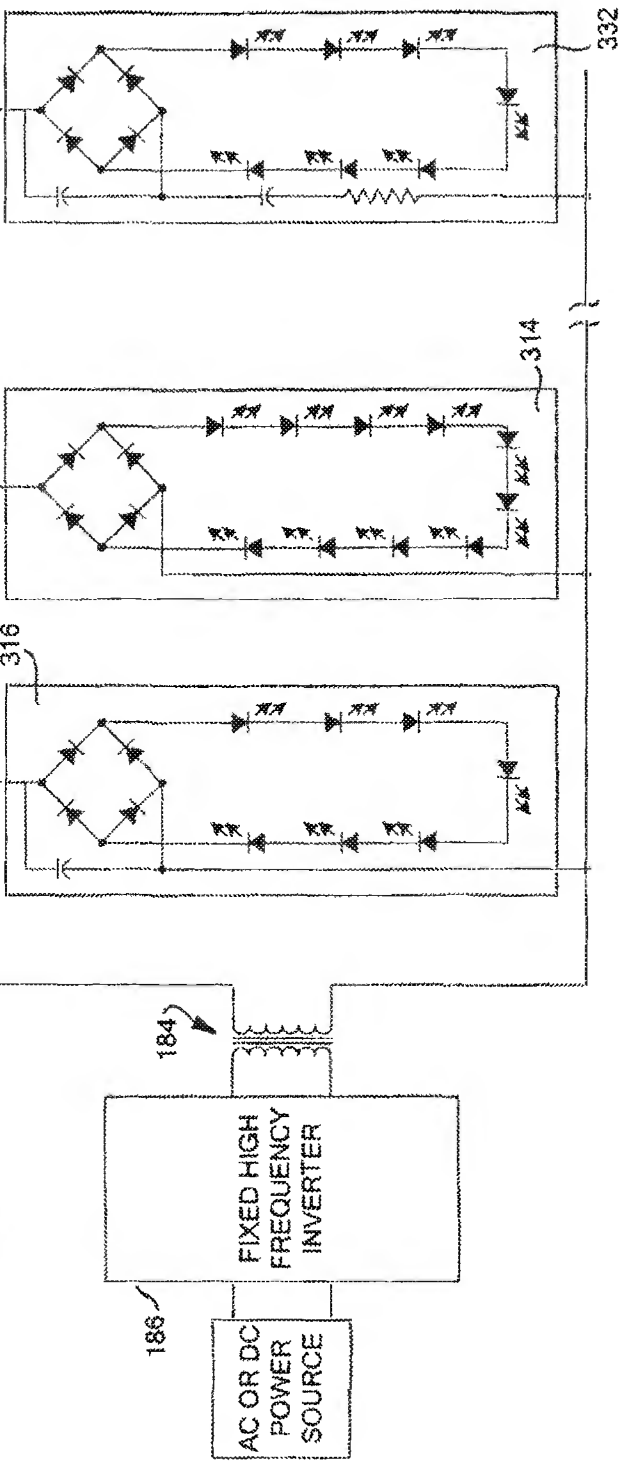

332
314
316
184
FIXED HIGH FREQUENCY INVERTER
186
AC OR DC POWER SOURCE

FIG. 23

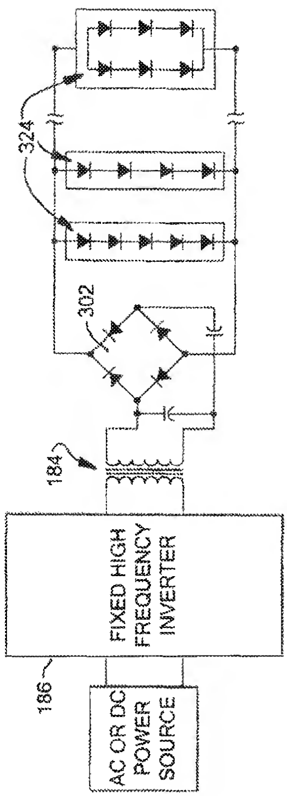

AC OR DC POWER SOURCE
186
FIXED HIGH FREQUENCY INVERTER
184
302
324

FIG. 24

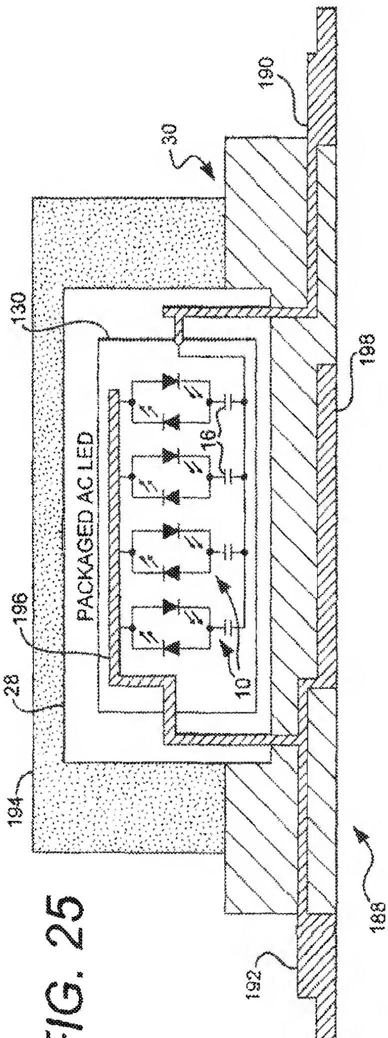
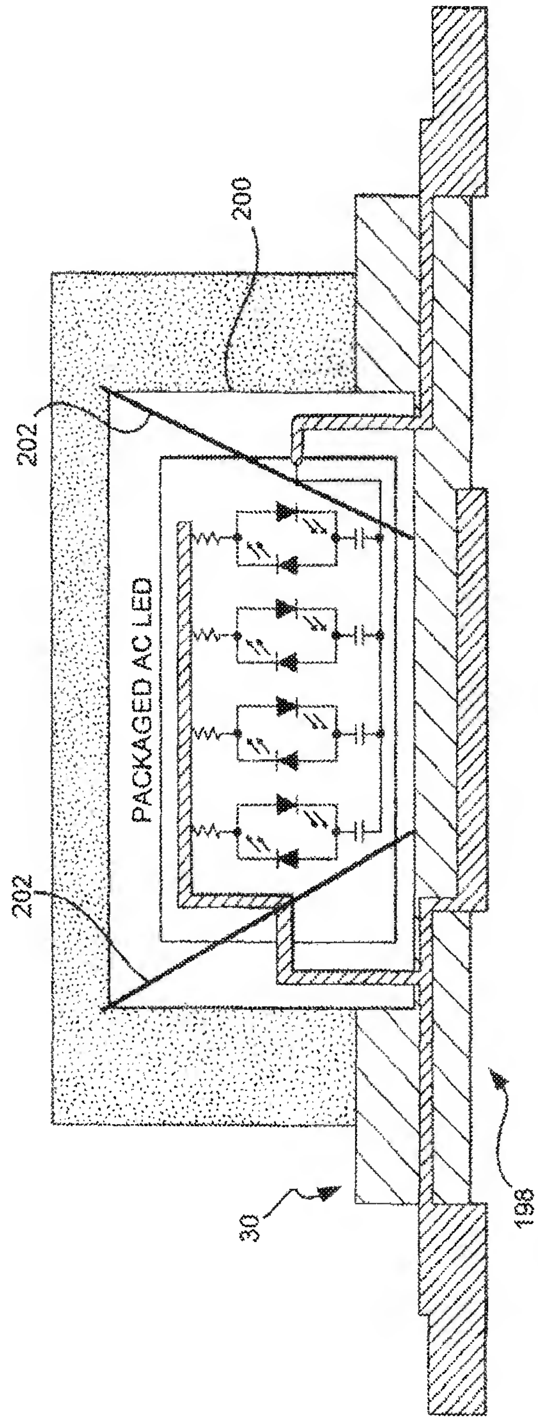

194
28
196
130
PACKAGED AC LED
16
10
30
190
198
188
192

FIG. 25

FIG. 26



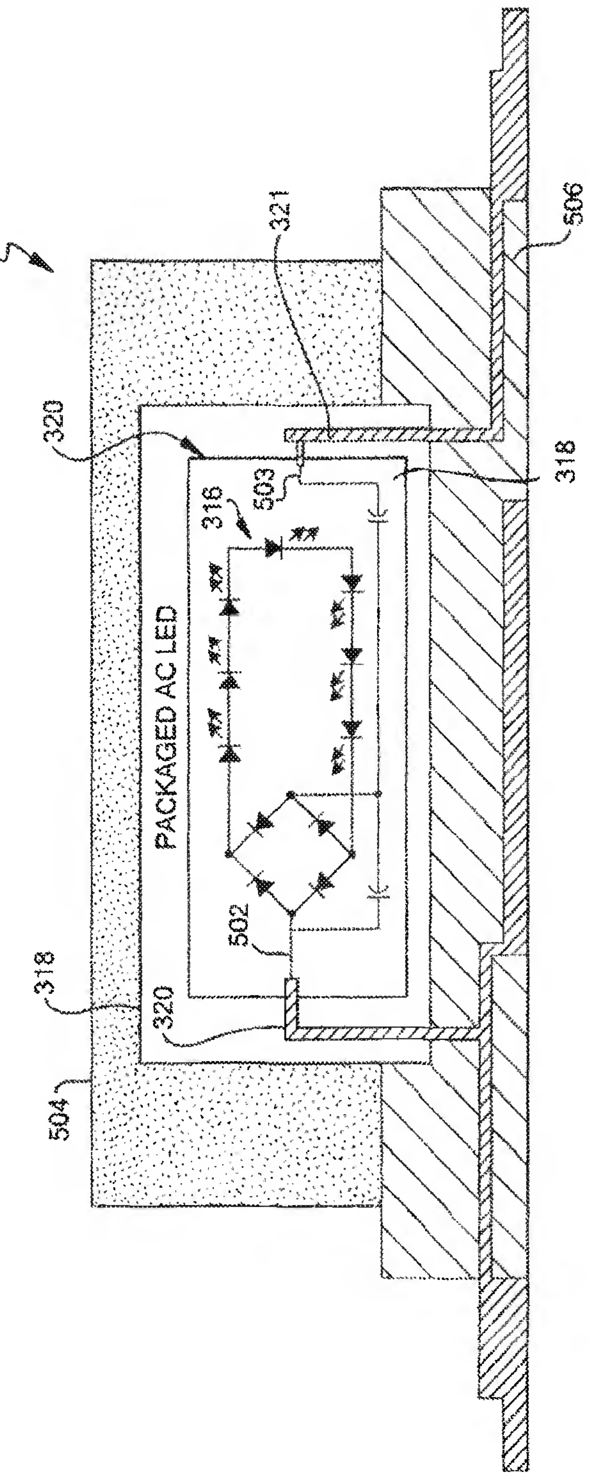


FIG. 27

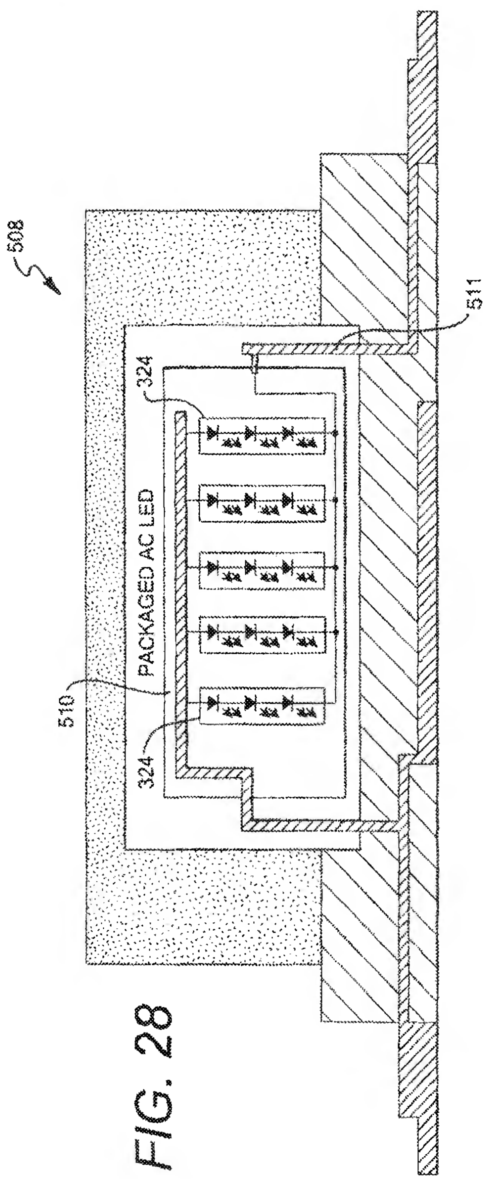

508
511
324
PACKAGED AC LED
510
324

FIG. 28

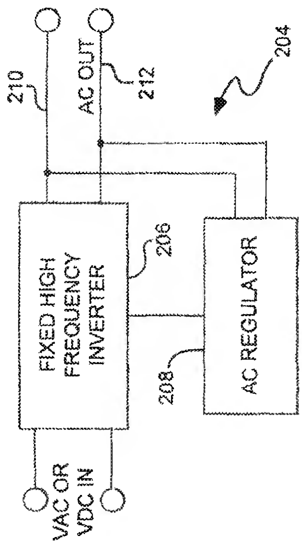

210
AC OUT
212
204
FIXED HIGH FREQUENCY INVERTER
206
AC REGULATOR
208
VAC OR VDC IN

FIG. 29

FIG. 30A

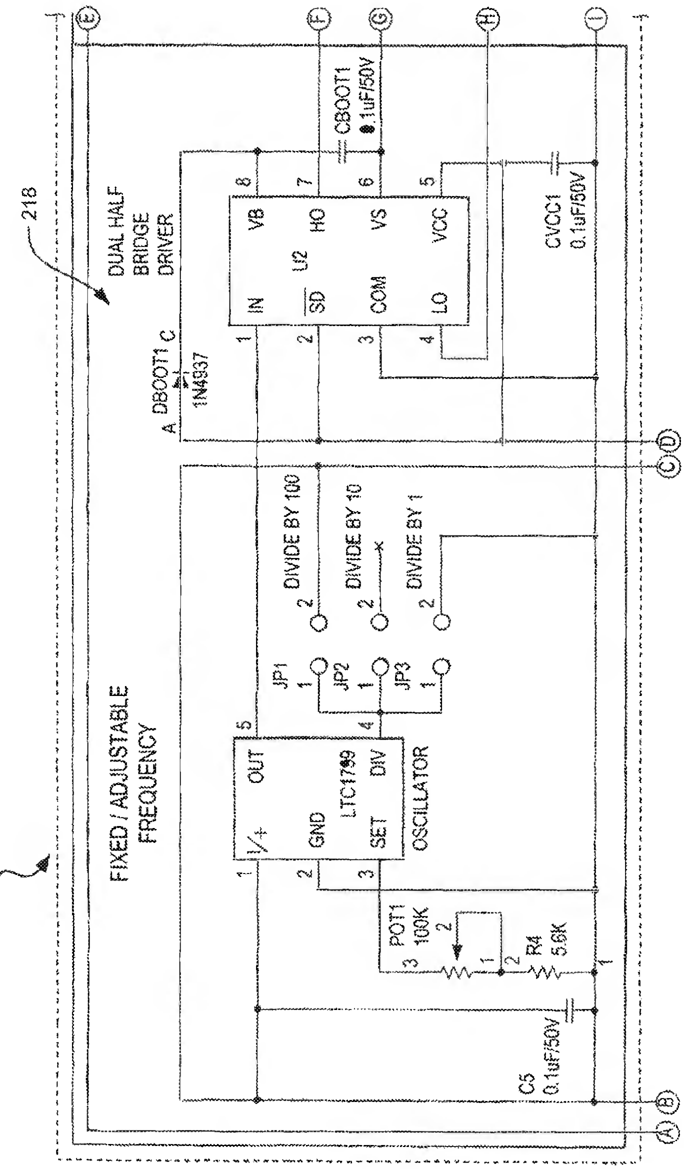
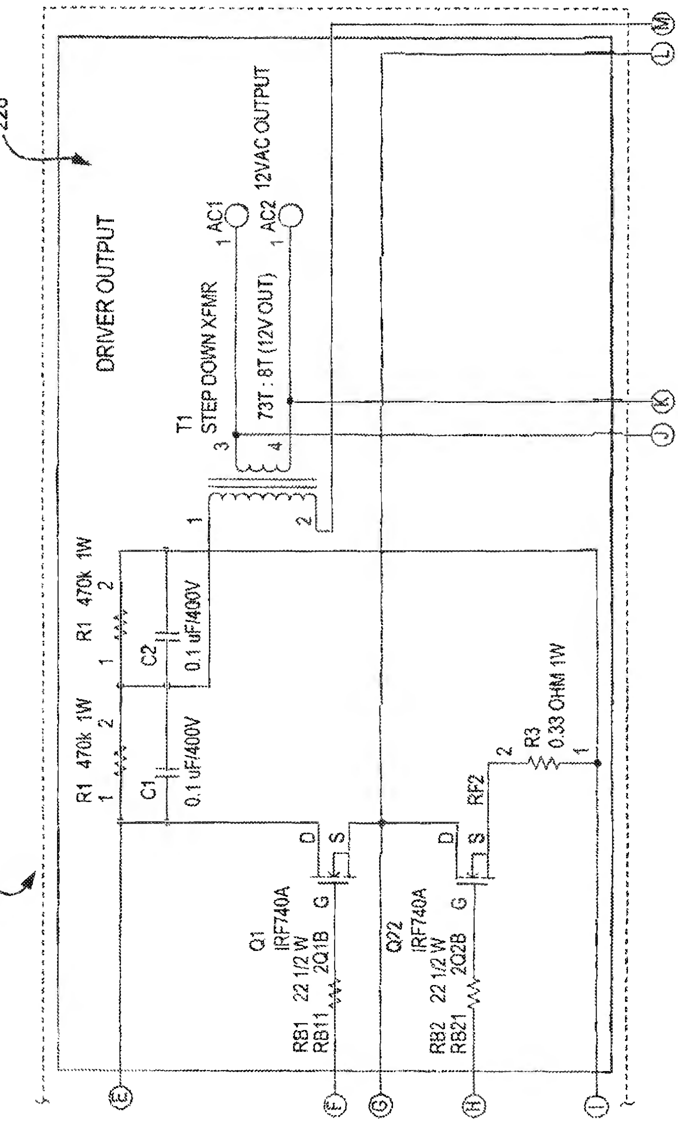
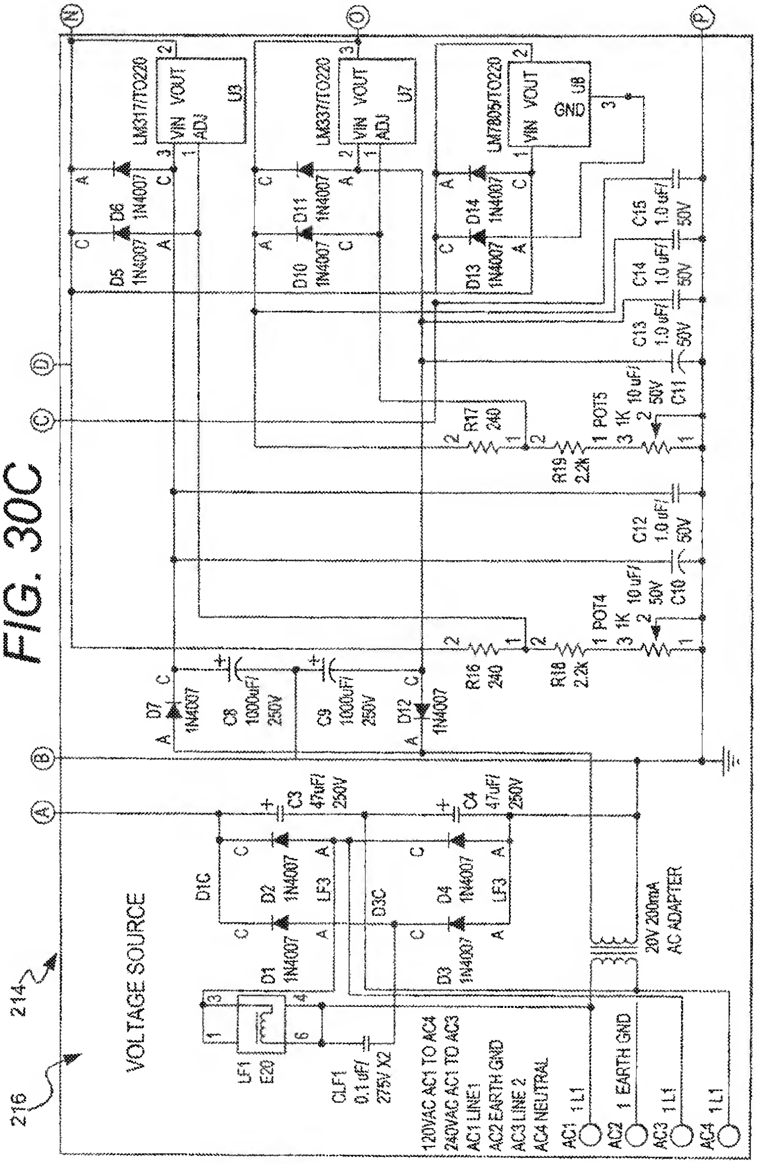

214
218
FIXED / ADJUSTABLE FREQUENCY
DUAL HALF BRIDGE DRIVER
U2
IN
SD
COM
LO
VB
HO
VS
VCC
CBOOT1 0.1uF/50V
CVCC1 0.1uF/50V
DBOOT1 1N4937
LTC1799
OSCILLATOR
OUT
GND
SET
DIV
JP1
JP2
JP3
DIVIDE BY 100
DIVIDE BY 10
DIVIDE BY 1
POT1 100K
R4 5.6K
C5 0.1uF/50V

FIG. 30B



214
226
DRIVER OUTPUT
R1 470k 1W
C1
0.1 uF/400V
C2
0.1 uF/400V
T1
STEP DOWN XFMR
73T : 8T (12V OUT)
AC1
AC2
12VAC OUTPUT
Q1
IRF740A
RB1 22 1/2 W
RB11 2Q1B
Q22
IRF740A
RB2 22 1/2 W
RB21 2Q2B
RF2
R3
0.33 OHM 1W
D
S
G
E
F
G
H
I
J
K
L
M

FIG. 30C



214
216
VOLTAGE SOURCE
LF1
E20
CLF1
0.1 uF/
275V X2
D1
1N4007
D2
1N4007
D3
1N4007
D4
1N4007
D1C
D3C
LF3
C3
47uF/
250V
C4
47uF/
250V
20V 200mA
AC ADAPTER
120VAC AC1 TO AC4
240VAC AC1 TO AC3
AC1 LINE1
AC2 EARTH GND
AC3 LINE 2
AC4 NEUTRAL
AC1
AC2
AC3
AC4
1 EARTH GND
D7
1N4007
D12
1N4007
C8
1000uF/
250V
C9
1000uF/
250V
R16
240
R18
2.2K
POT4
1K
C10
10 uF/
50V
C12
1.0 uF/
50V
R17
240
R19
2.2K
POT5
1K
C11
10 uF/
50V
C13
1.0 uF/
50V
C14
1.0 uF/
50V
C15
1.0 uF/
50V
D5
1N4007
D6
1N4007
D10
1N4007
D11
1N4007
D13
1N4007
D14
1N4007
LM317/TO220
U3
LM337/TO220
U7
LM7805/TO220
U8
VIN
VOUT
ADJ
GND

FIG. 30D

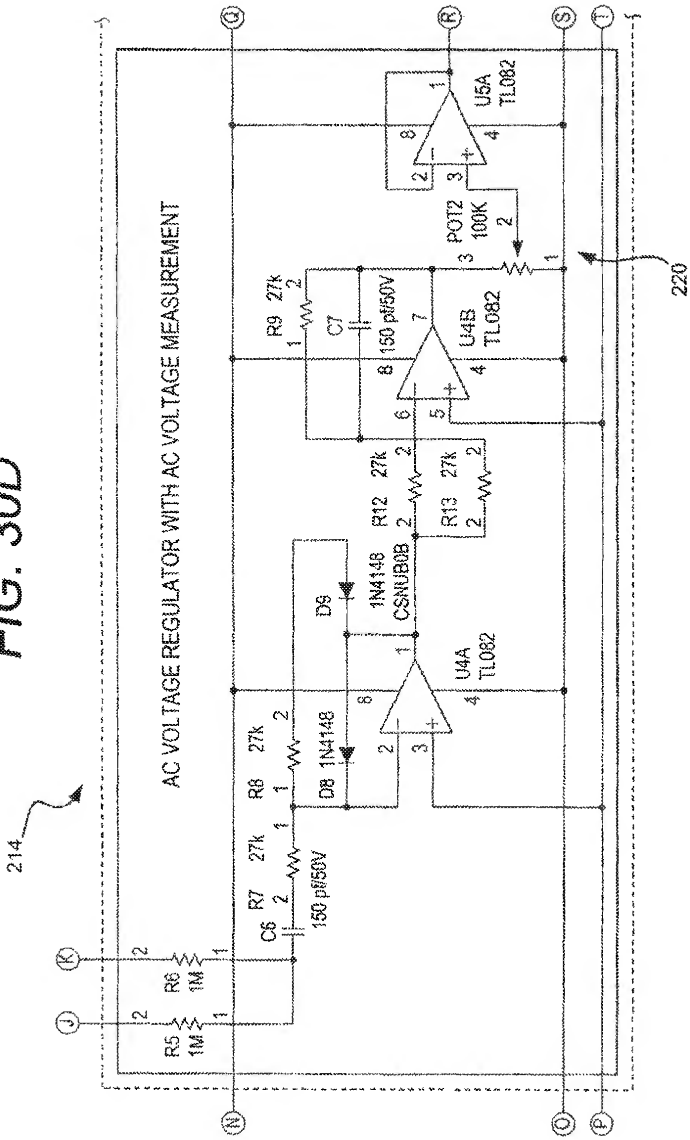
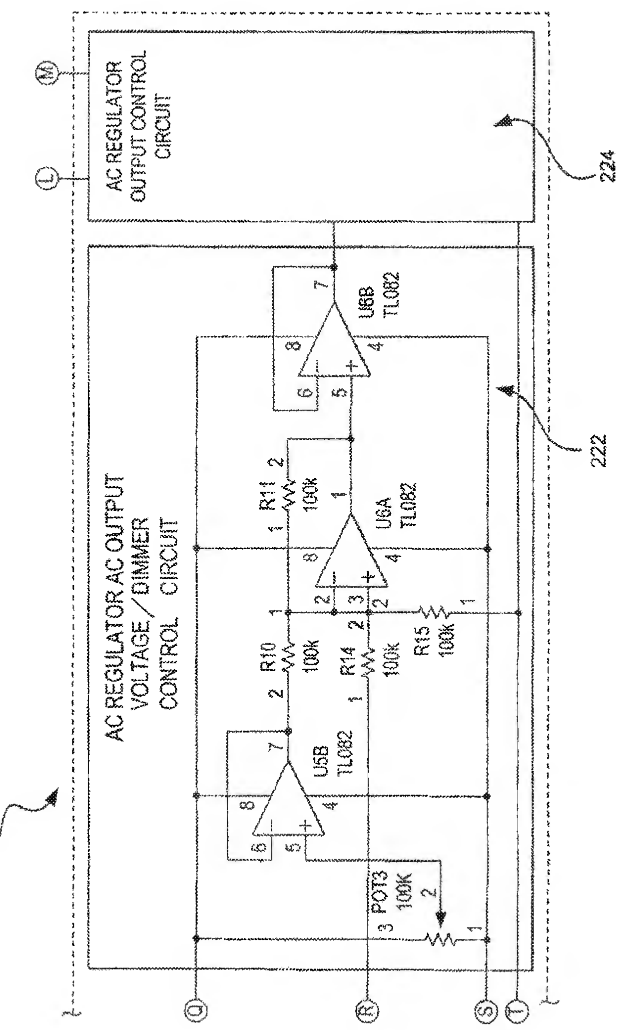

AC VOLTAGE REGULATOR WITH AC VOLTAGE MEASUREMENT
214
220
R5 1M
R6 1M
C6 150 pf/50V
R7 27k
R8 27k
D8 1N4148
D9 1N4148
CSNUB0B
U4A TL082
R12 27k
R13 27k
R9 27k
C7 150 pf/50V
U4B TL082
POT2 100K
U5A TL082
J
K
N
O
P
Q
R
S
T

FIG. 30E



AC REGULATOR OUTPUT CONTROL CIRCUIT
224
AC REGULATOR AC OUTPUT VOLTAGE / DIMMER CONTROL CIRCUIT
222
214
U5B TL082
U6A TL082
U6B TL082
R10 100k
R11 100k
R14 100k
R15 100k
POT3 100K
Q
R
S
T
L
M

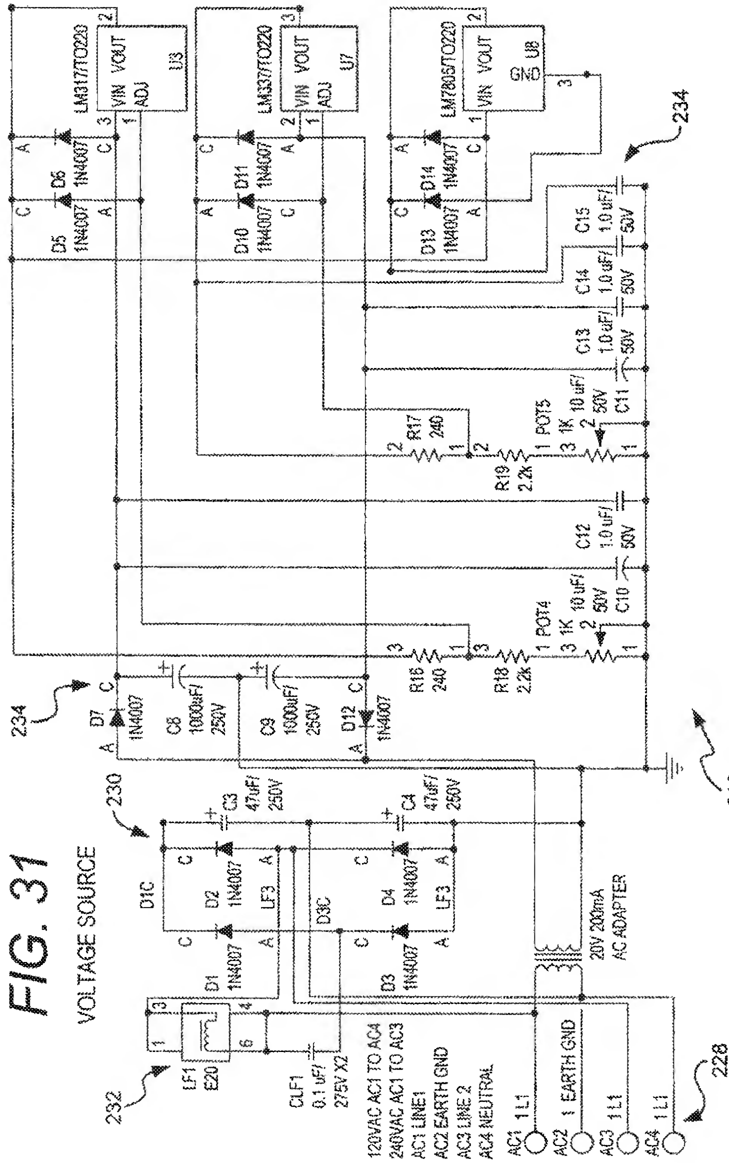


FIG. 31
VOLTAGE SOURCE

FIG. 32

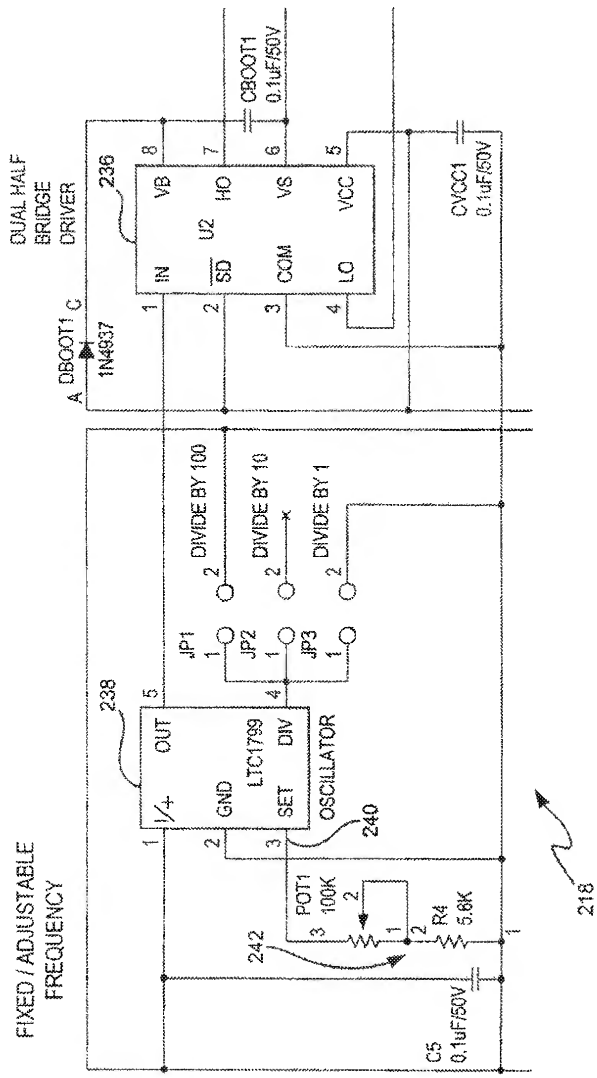
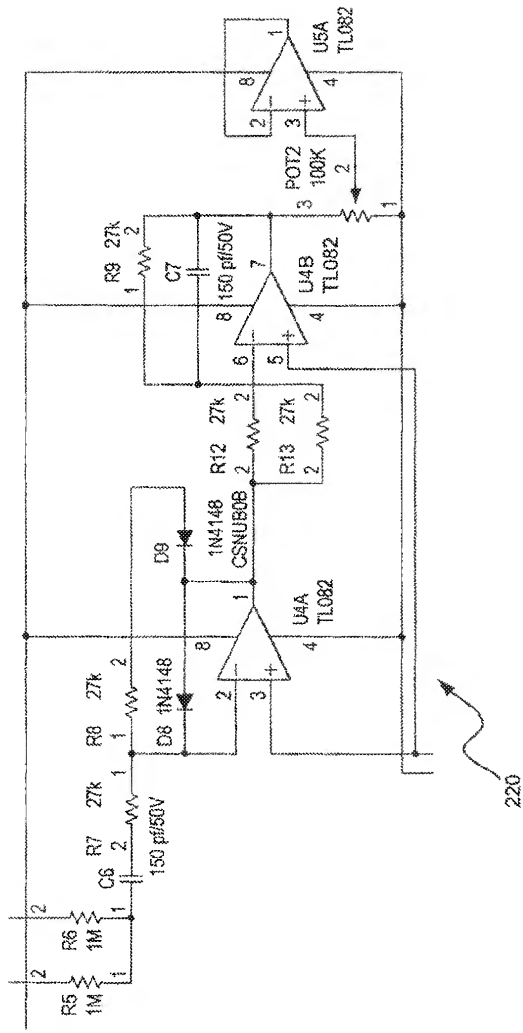

FIXED / ADJUSTABLE FREQUENCY
238
OUT
LTC1799
DIV
OSCILLATOR
GND
SET
240
POT1
100K
R4
5.6K
242
C5
0.1uF/50V
JP1
JP2
JP3
DIVIDE BY 100
DIVIDE BY 10
DIVIDE BY 1
218
DUAL HALF BRIDGE DRIVER
236
DBOOT1
1N4937
IN
SD
COM
LO
U2
VB
HO
VS
VCC
CBOOT1
0.1uF/50V
CVCC1
0.1uF/50V

FIG. 33

AC VOLTAGE REGULATOR WITH VOLTAGE MEASUREMENT



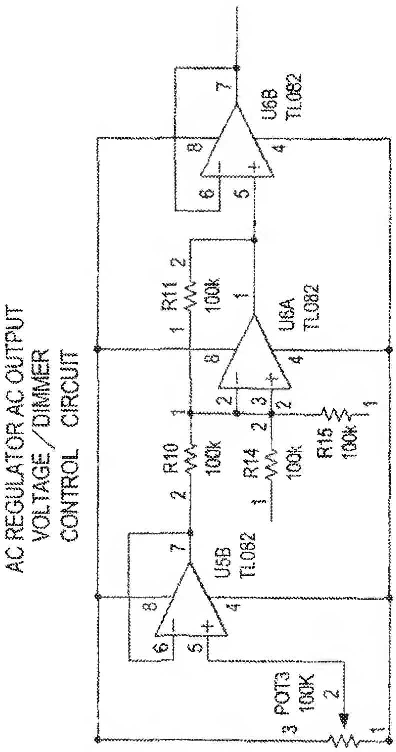


FIG. 34

228

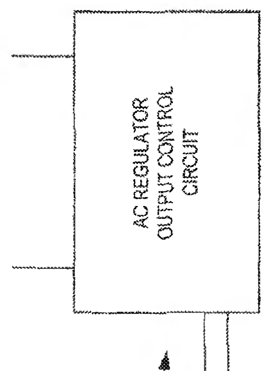
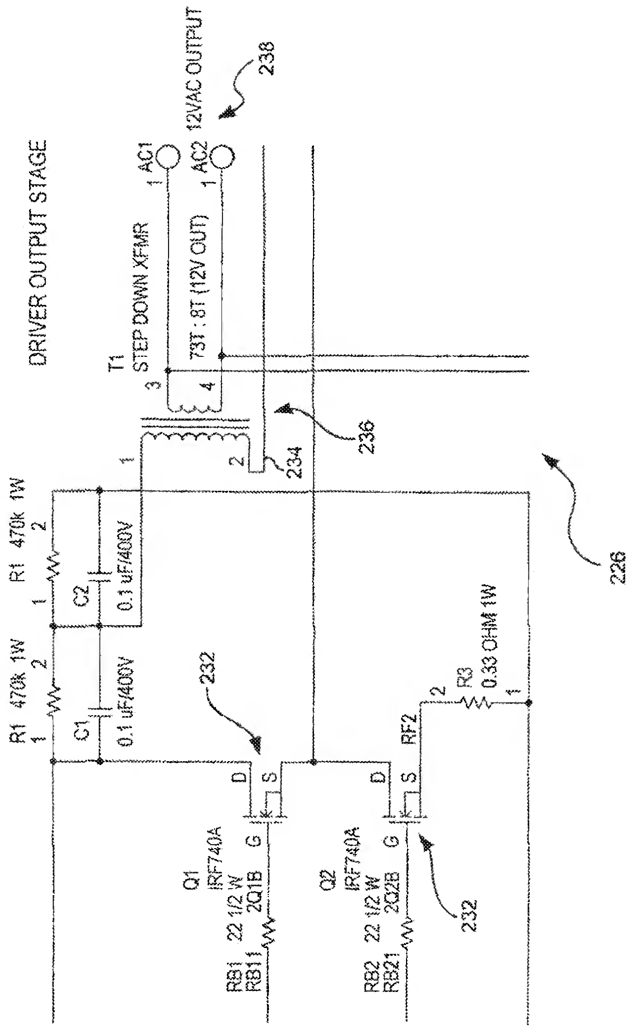


FIG. 36

230

FIG. 35


DRIVER OUTPUT STAGE
T1
STEP DOWN XFMR
73T : 8T (12V OUT)
AC1
AC2
12VAC OUTPUT
238
236
234
226
R1 470k 1W
C2 0.1 uF/400V
C1 0.1 uF/400V
232
Q1 IRF740A
Q2 IRF740A
RB1 22 1/2 W
RB11 2Q1B
RB2 22 1/2 W
RB21 2Q2B
RF2
R3 0.33 OHM 1W
D
S
G

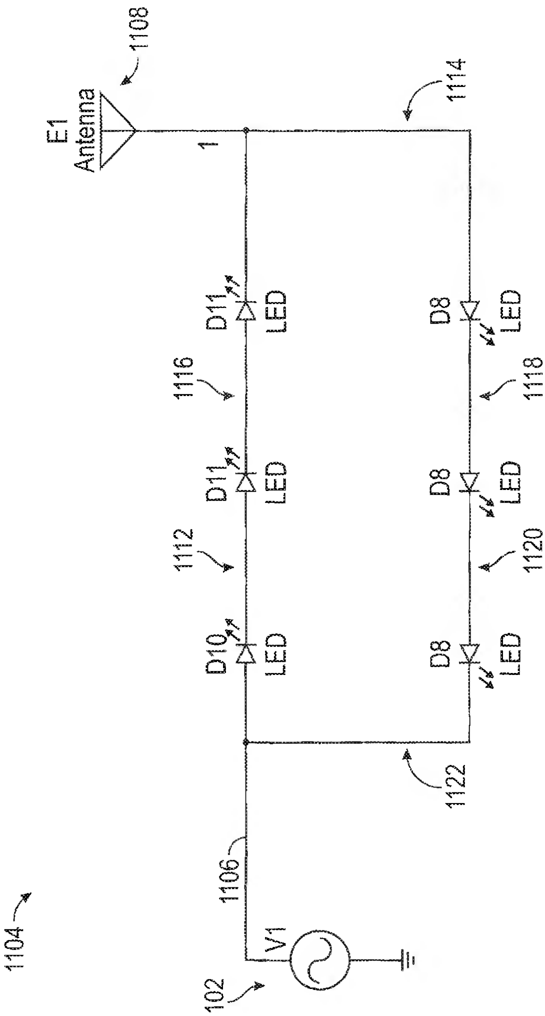

1108
E1
Antenna
1
1114
D11
LED
D8
LED
1116
1118
D11
LED
D8
LED
1112
1120
D10
LED
D8
LED
1122
1106
V1
1104
1102

FIG. 37

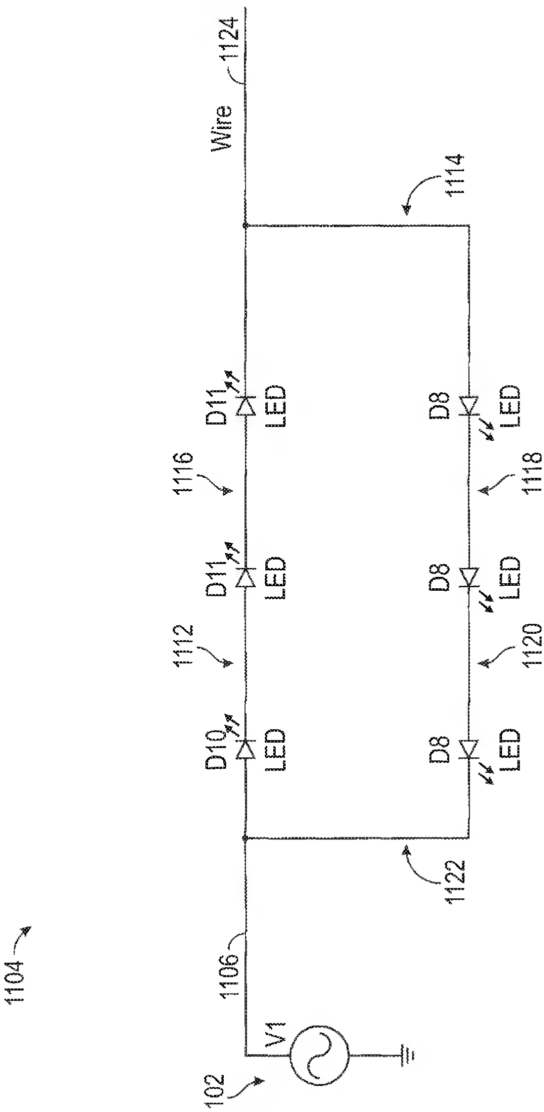

1124
Wire
1114
D11
LED
D8
LED
1116
1118
D11
LED
D8
LED
1112
1120
D10
LED
D8
LED
1122
1106
V1
1102
1104

FIG. 38

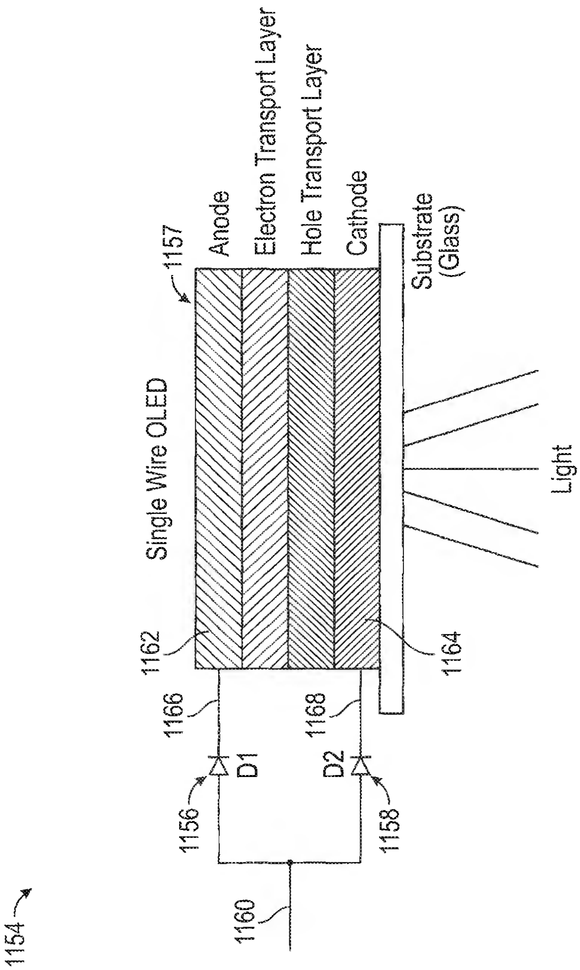

1154
1160
1156
D1
1158
D2
1166
1168
1162
1164
Single Wire OLED
1157
Anode
Electron Transport Layer
Hole Transport Layer
Cathode
Substrate
(Glass)
Light

FIG. 39

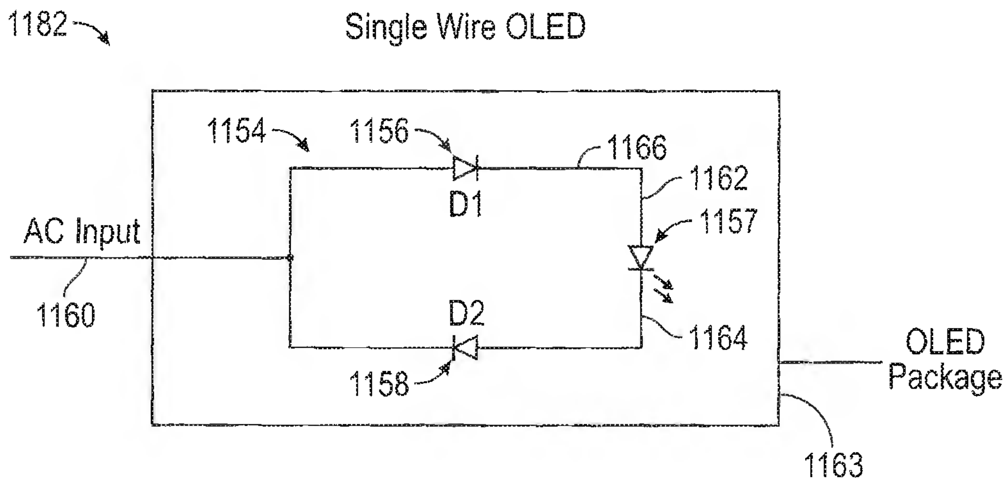

1182
Single Wire OLED
1154
1156
1166
1162
1157
AC Input
D1
1160
D2
1164
1158
OLED
Package
1163

FIG. 40

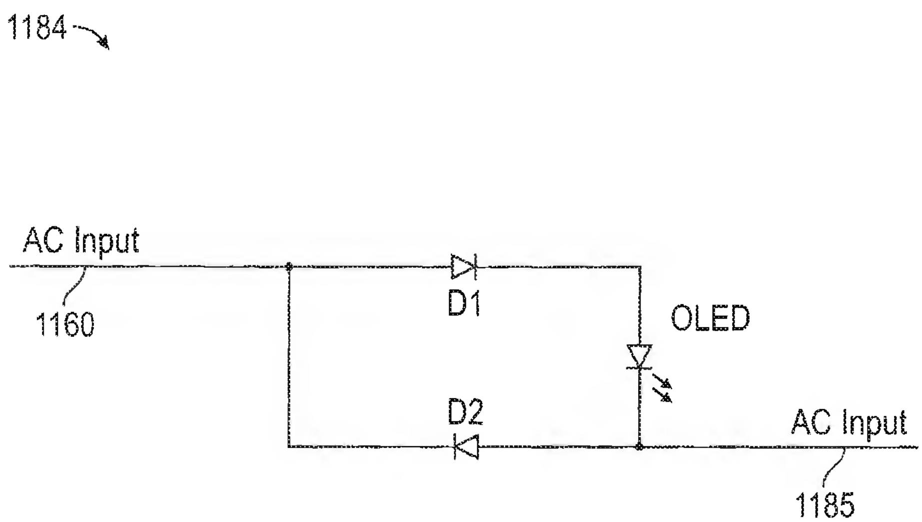

1184
AC Input
D1
1160
OLED
D2
AC Input
1185

FIG. 41

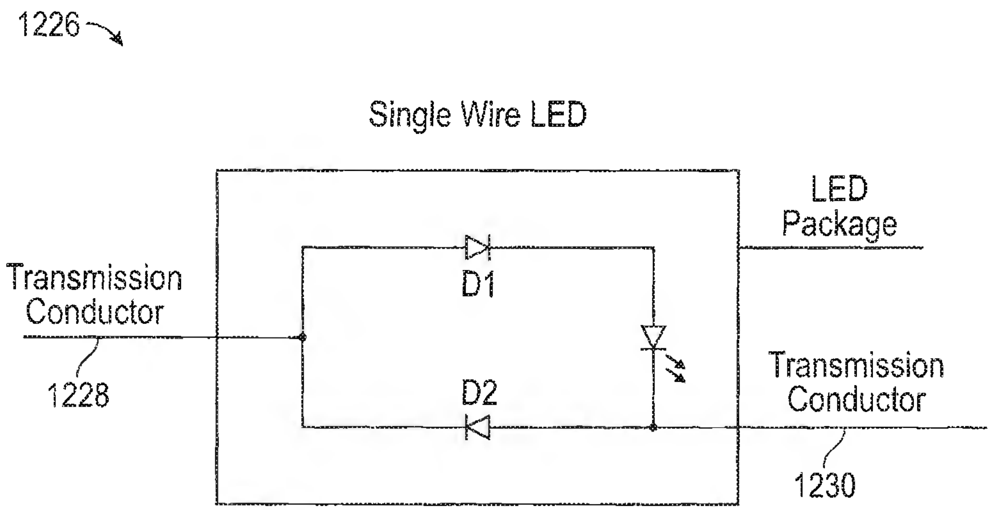

1226
Single Wire LED
LED Package
Transmission Conductor
D1
D2
Transmission Conductor
1228
1230

FIG. 42

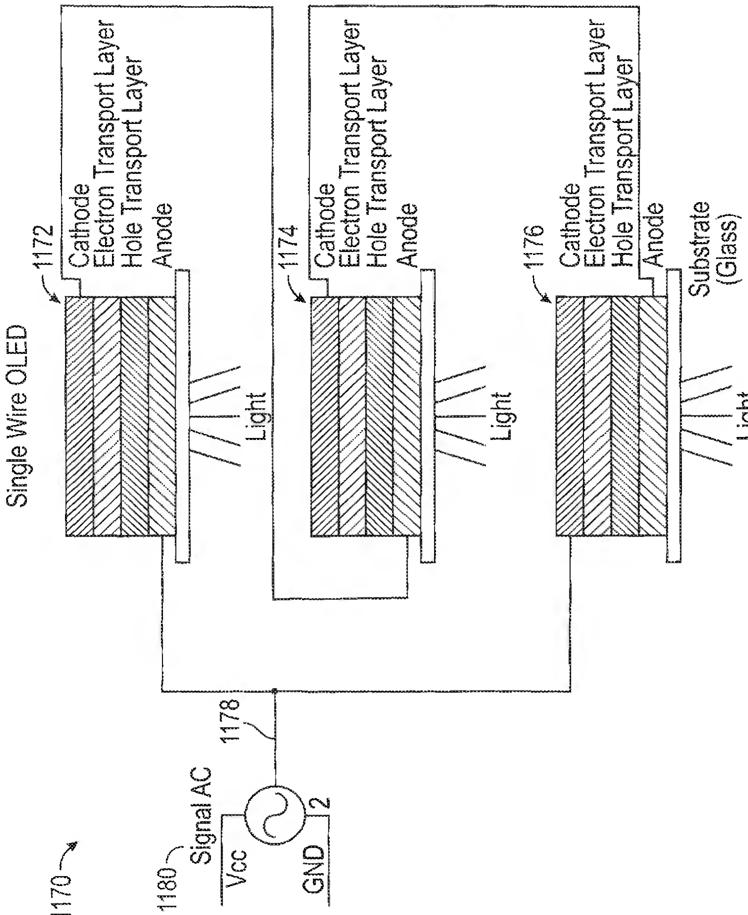

1170
Single Wire OLED
1172
Cathode
Electron Transport Layer
Hole Transport Layer
Anode
Light
1174
Cathode
Electron Transport Layer
Hole Transport Layer
Anode
Light
1176
Cathode
Electron Transport Layer
Hole Transport Layer
Anode
Substrate
(Glass)
Light
1178
1180
Signal AC
Vcc
GND
2

FIG. 43

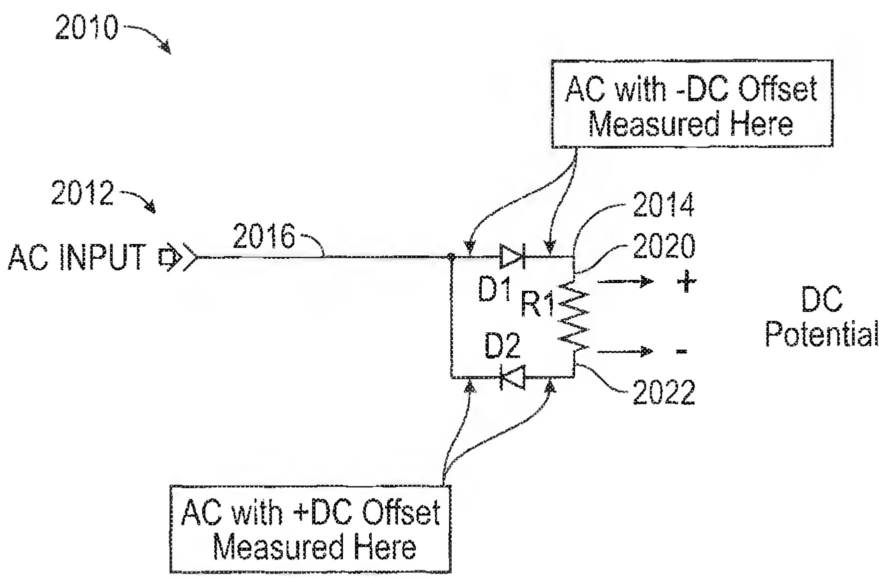

2010
AC with -DC Offset Measured Here
2012
2014
2016
2020
AC INPUT
D1
R1
+
DC Potential
D2
-
2022
AC with +DC Offset Measured Here

FIG. 44

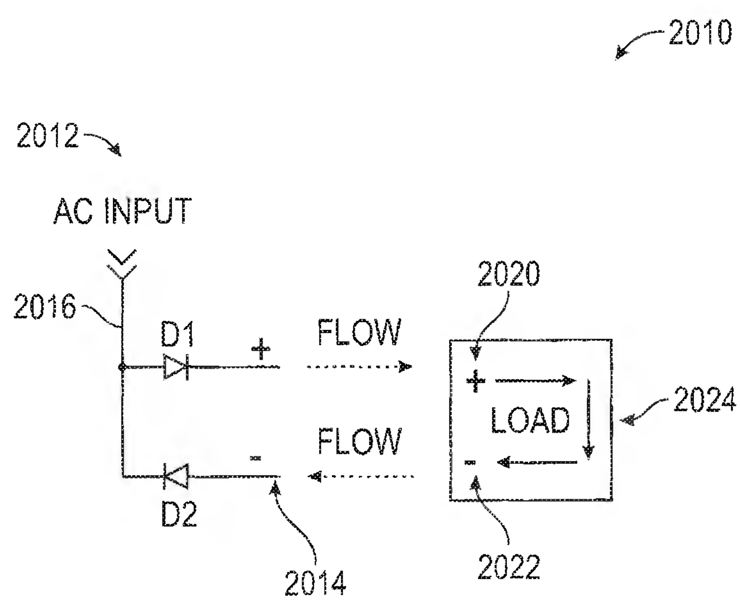
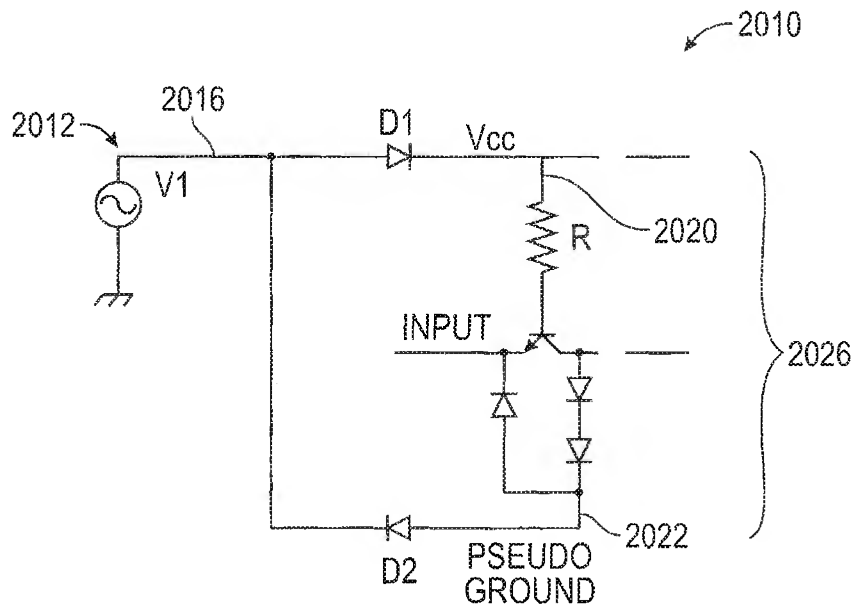
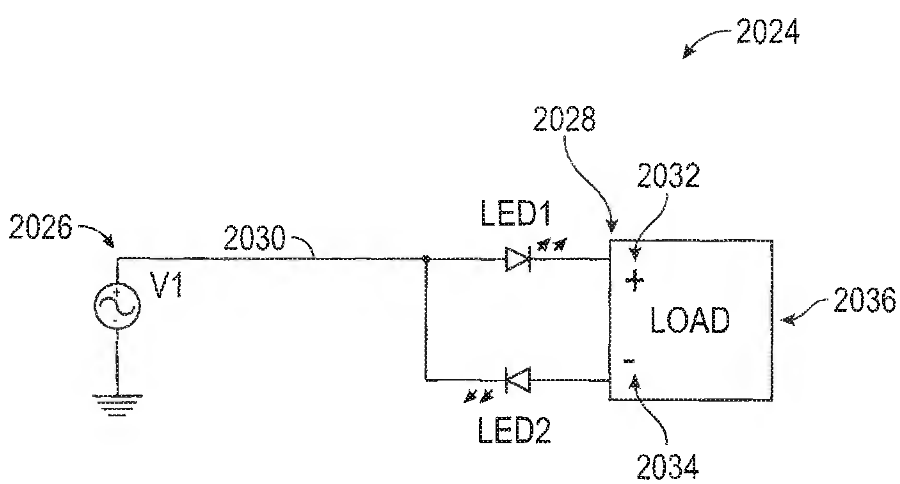

2010
2012
AC INPUT
2020
2016
D1
+
FLOW
LOAD
2024
FLOW
-
D2
2014
2022

FIG. 45



2010
2012
2016
D1
Vcc
V1
2020
R
INPUT
2026
2022
D2
PSEUDO
GROUND

FIG. 46



2024
2028
2032
LED1
2026
2030
V1
+
LOAD
2036
-
LED2
2034

FIG. 47

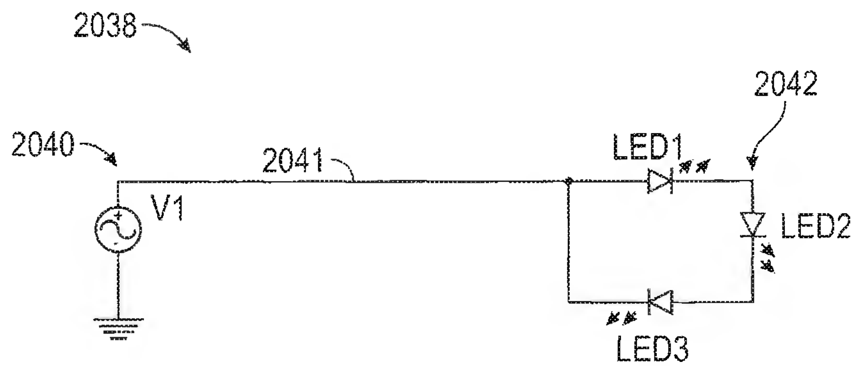

2038
2040
2041
2042
V1
LED1
LED2
LED3

FIG. 48

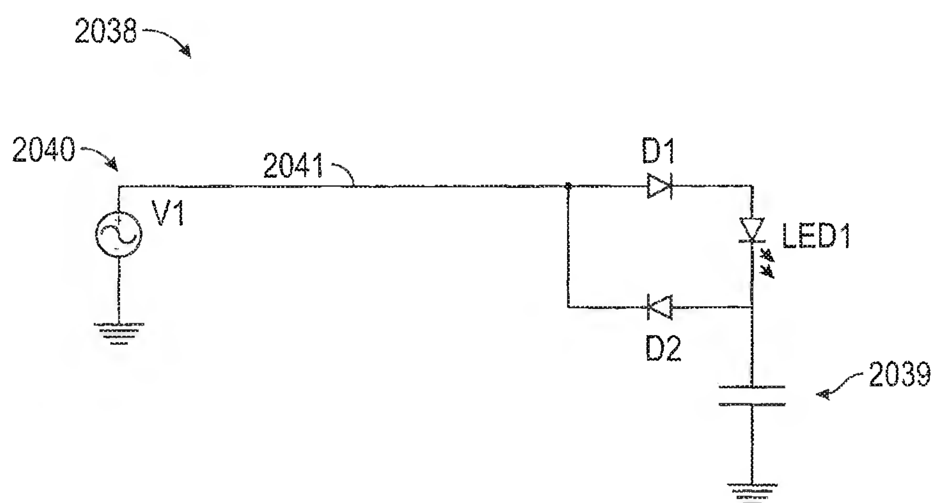
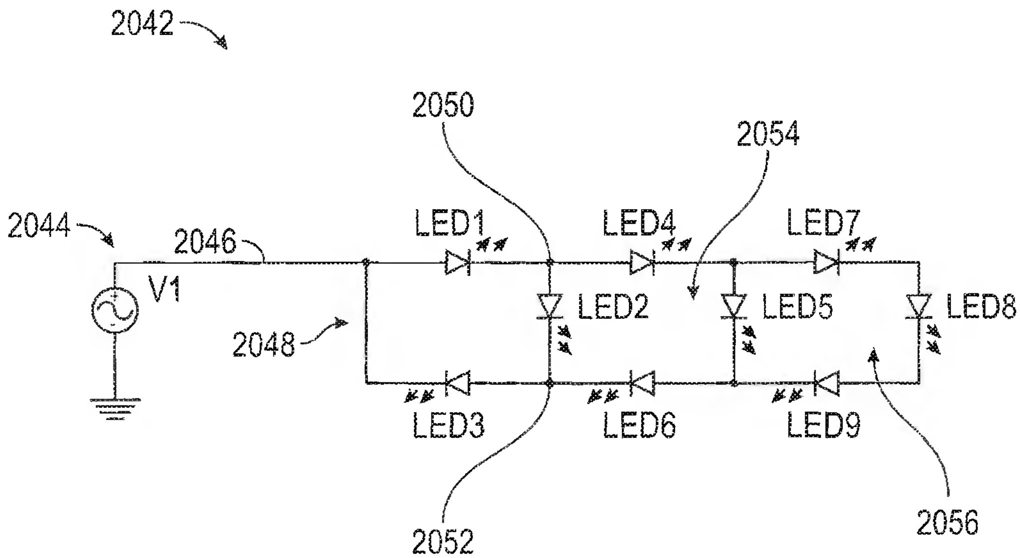
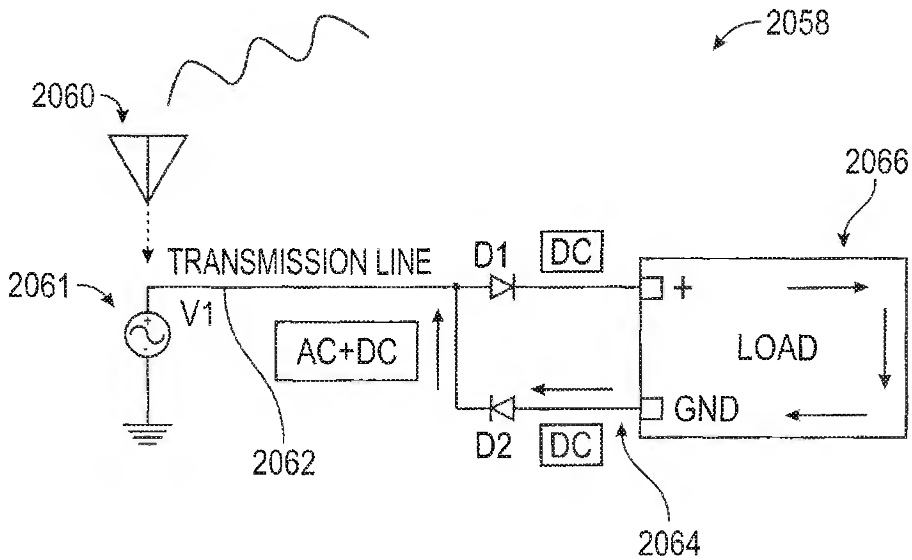

2038
2040
2041
V1
D1
LED1
D2
2039

FIG. 49



2042
2050
2054
2044
2046
LED1
LED4
LED7
V1
LED2
LED5
LED8
2048
LED3
LED6
LED9
2052
2056

FIG. 50



2058
2060
2066
TRANSMISSION LINE
D1
DC
2061
V1
+
AC+DC
LOAD
GND
D2
DC
2062
2064

FIG. 51

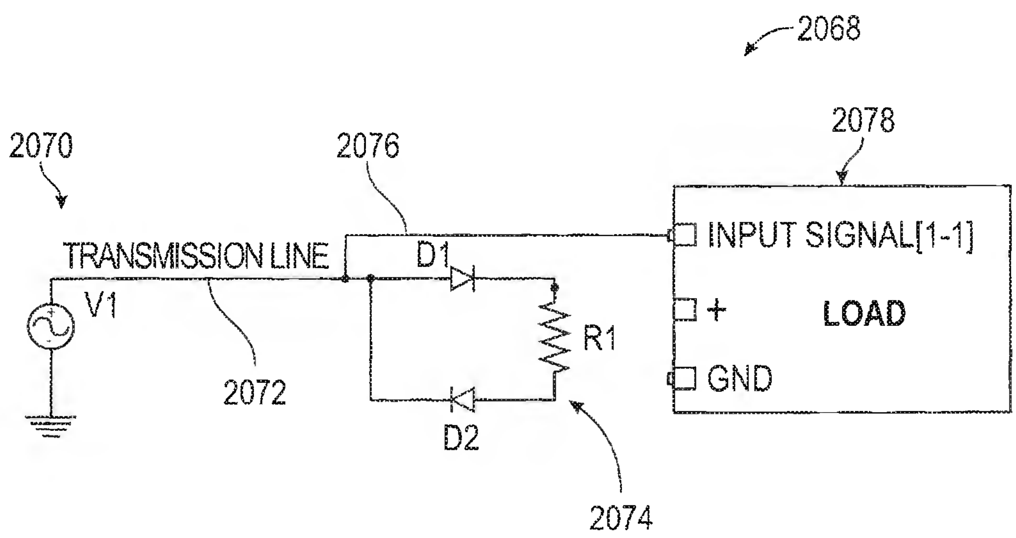

2068
2070
2076
2078
TRANSMISSION LINE
D1
INPUT SIGNAL[1-1]
V1
+
LOAD
R1
GND
2072
D2
2074

FIG. 52

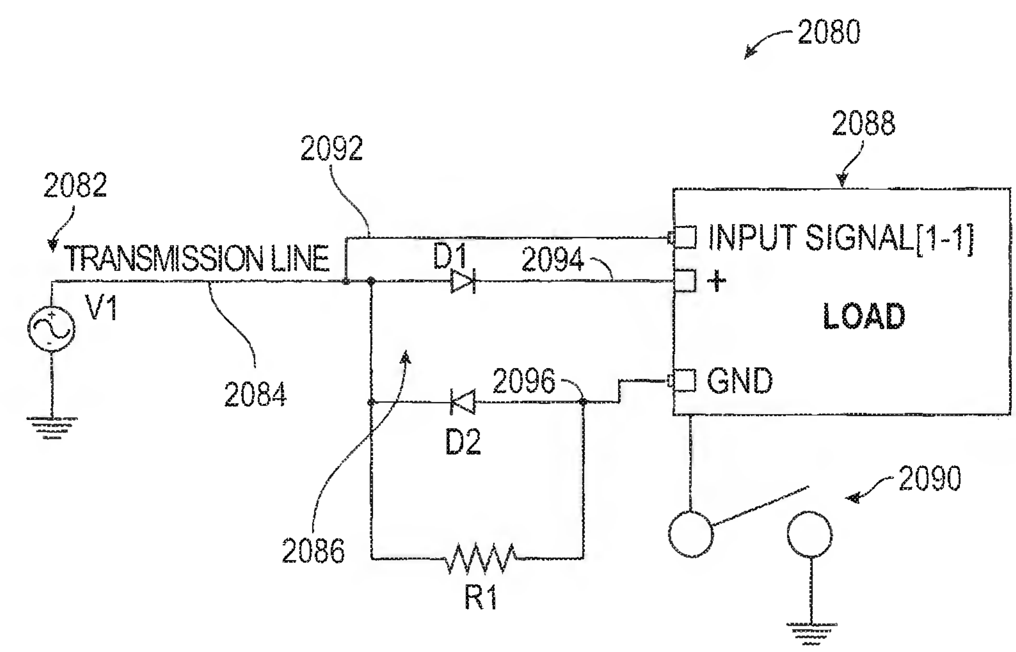

2080
2088
2092
2082
TRANSMISSION LINE
INPUT SIGNAL[1-1]
D1
2094
+
V1
LOAD
2096
GND
2084
D2
2090
2086
R1

FIG. 53

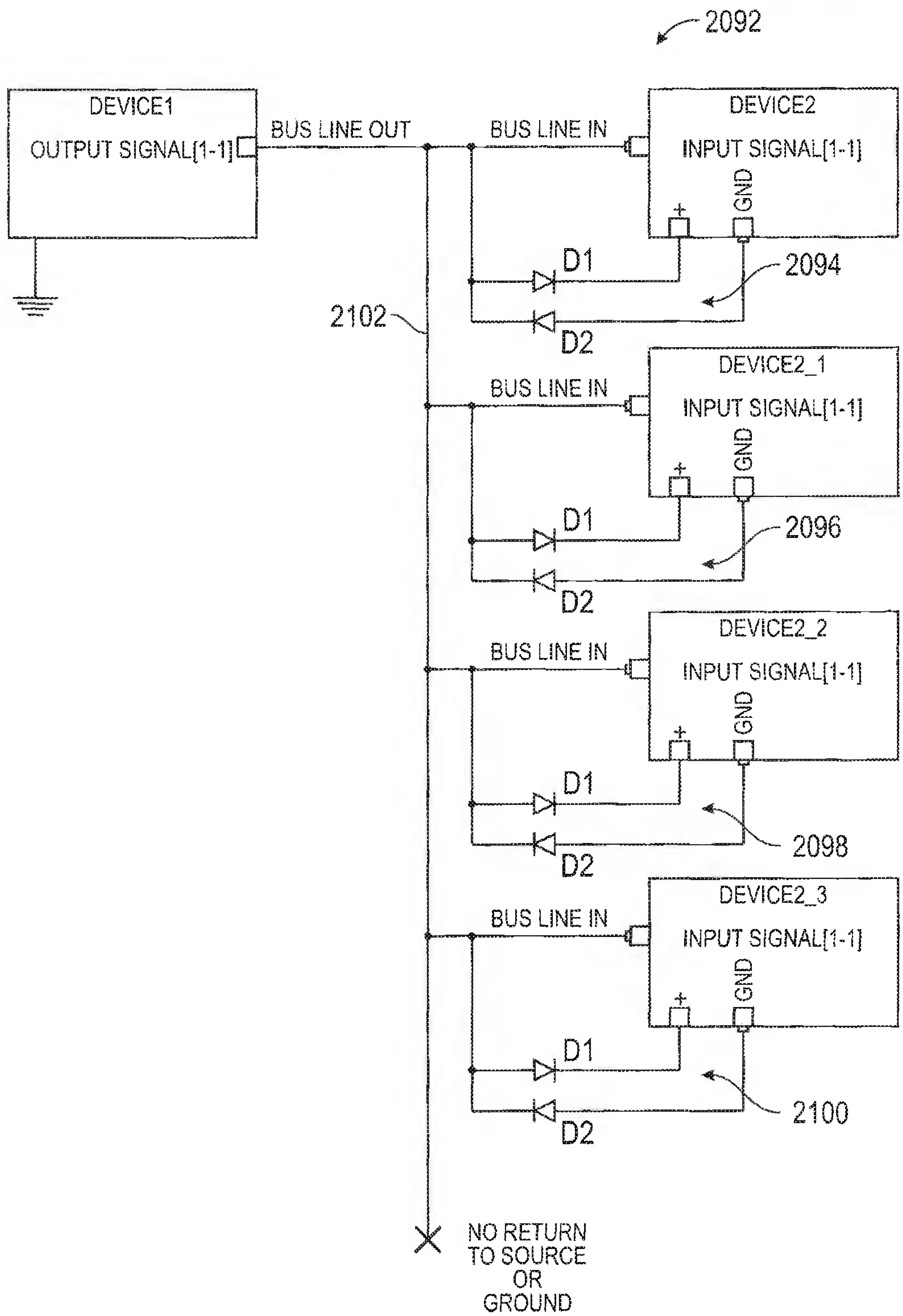

2092
DEVICE1
OUTPUT SIGNAL[1-1]
BUS LINE OUT
BUS LINE IN
DEVICE2
INPUT SIGNAL[1-1]
GND
+
D1
D2
2094
2102
BUS LINE IN
DEVICE2_1
INPUT SIGNAL[1-1]
GND
+
D1
D2
2096
BUS LINE IN
DEVICE2_2
INPUT SIGNAL[1-1]
GND
+
D1
D2
2098
BUS LINE IN
DEVICE2_3
INPUT SIGNAL[1-1]
GND
+
D1
D2
2100
NO RETURN TO SOURCE OR GROUND

FIG. 54

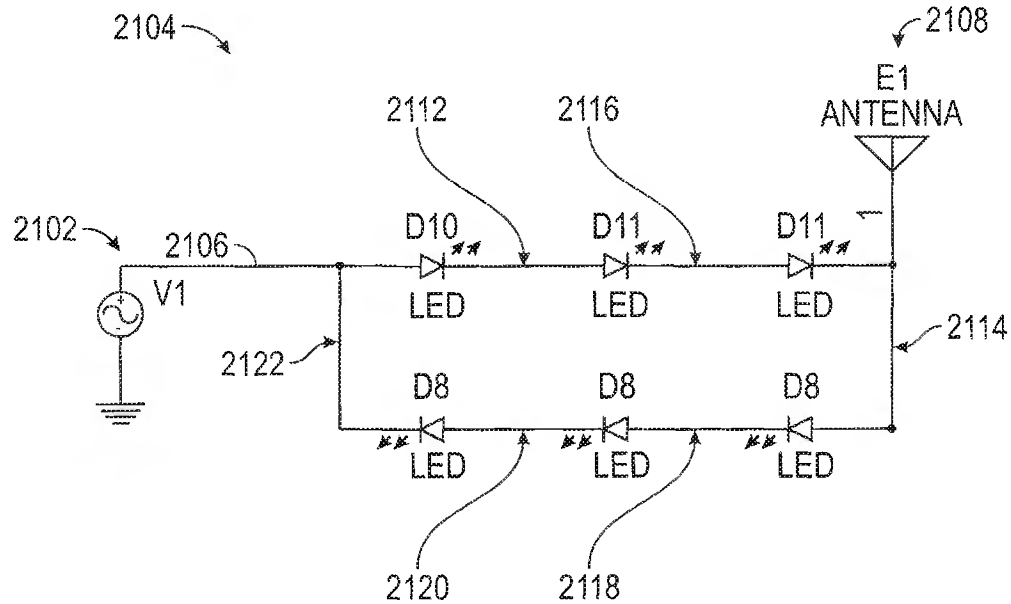

2104
2108
E1
ANTENNA
2112
2116
2102
2106
D10
D11
D11
LED
LED
LED
V1
2114
2122
D8
D8
D8
LED
LED
LED
2120
2118

FIG. 55

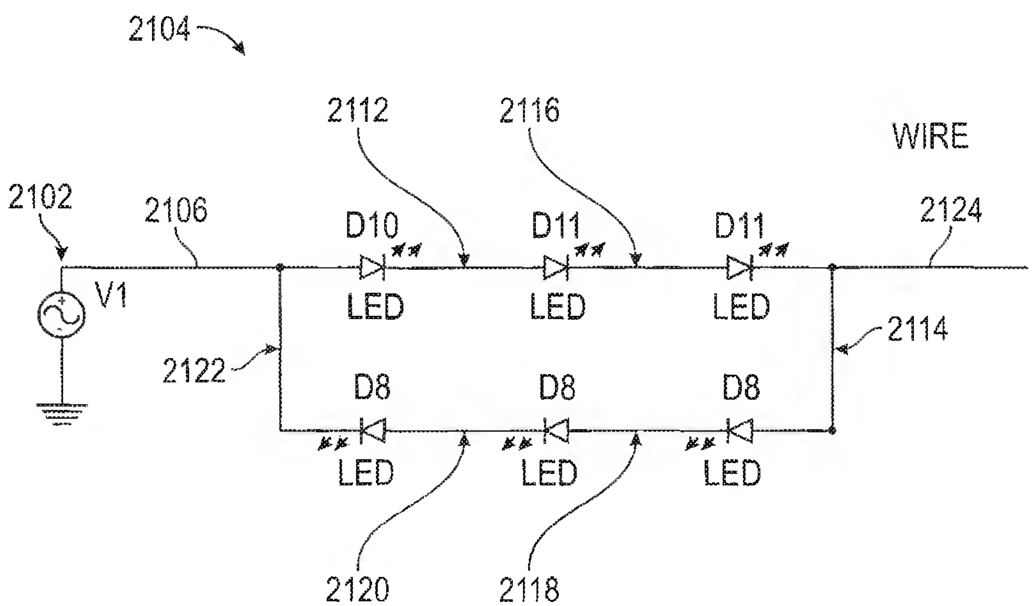

2104
2112
2116
WIRE
2102
2106
D10
D11
D11
2124
LED
LED
LED
V1
2114
2122
D8
D8
D8
LED
LED
LED
2120
2118

FIG. 56

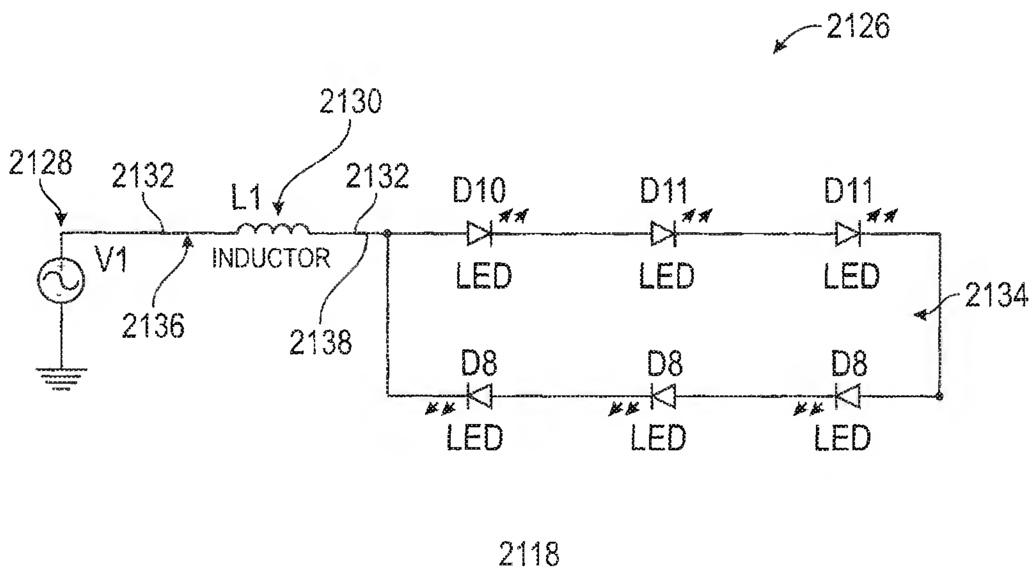

2126
2130
2128
2132
L1
2132
D10
D11
D11
V1
INDUCTOR
LED
LED
LED
2134
2136
2138
D8
D8
D8
LED
LED
LED
2118

FIG. 57

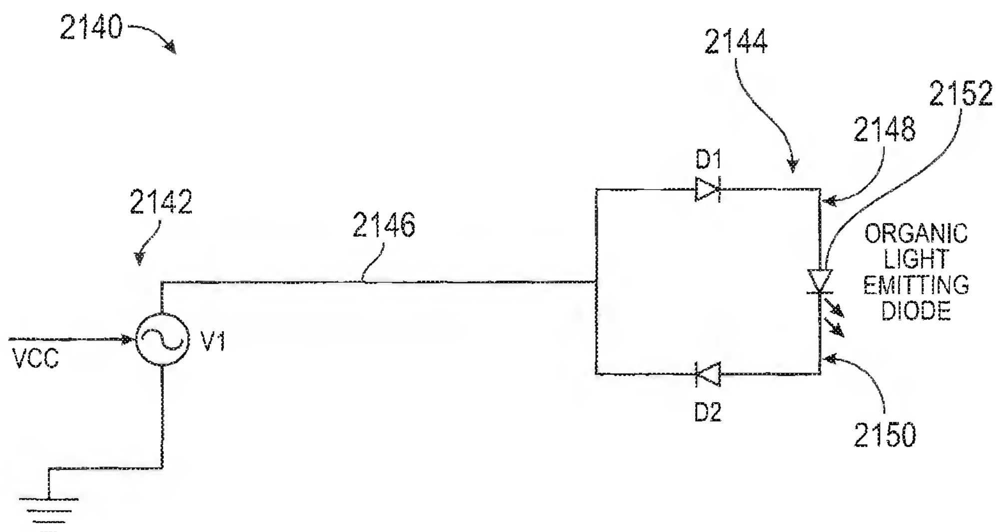

2140
2144
2152
2148
D1
2142
2146
ORGANIC LIGHT EMITTING DIODE
VCC
V1
D2
2150

FIG. 58

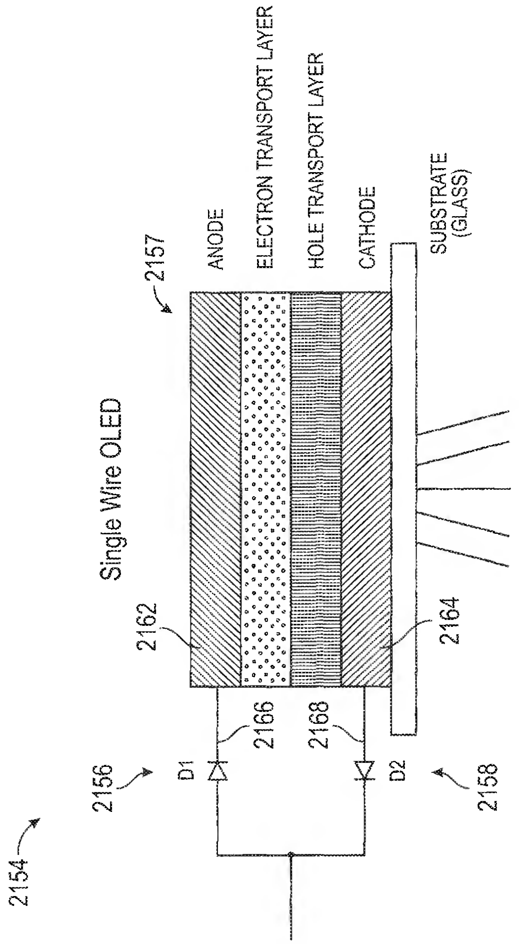

Single Wire OLED
2154
2156
2157
2158
2162
2164
2166
2168
D1
D2
ANODE
ELECTRON TRANSPORT LAYER
HOLE TRANSPORT LAYER
CATHODE
SUBSTRATE
(GLASS)
LIGHT

FIG. 59

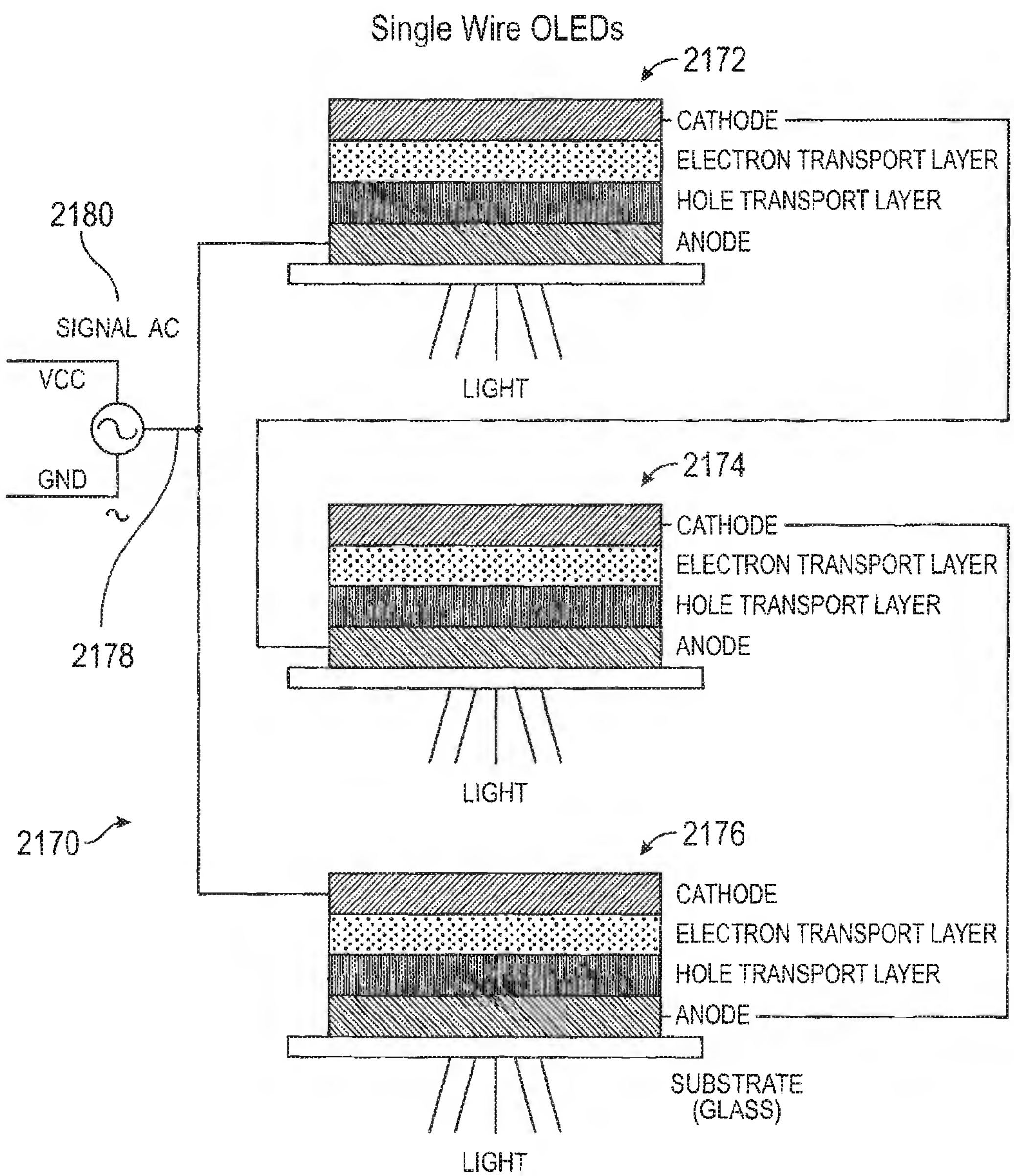

Single Wire OLEDs
2172
CATHODE
ELECTRON TRANSPORT LAYER
HOLE TRANSPORT LAYER
ANODE
LIGHT
2180
SIGNAL AC
VCC
GND
2178
2174
CATHODE
ELECTRON TRANSPORT LAYER
HOLE TRANSPORT LAYER
ANODE
LIGHT
2170
2176
CATHODE
ELECTRON TRANSPORT LAYER
HOLE TRANSPORT LAYER
ANODE
SUBSTRATE
(GLASS)
LIGHT

FIG. 60

SINGLE WIRE OLED

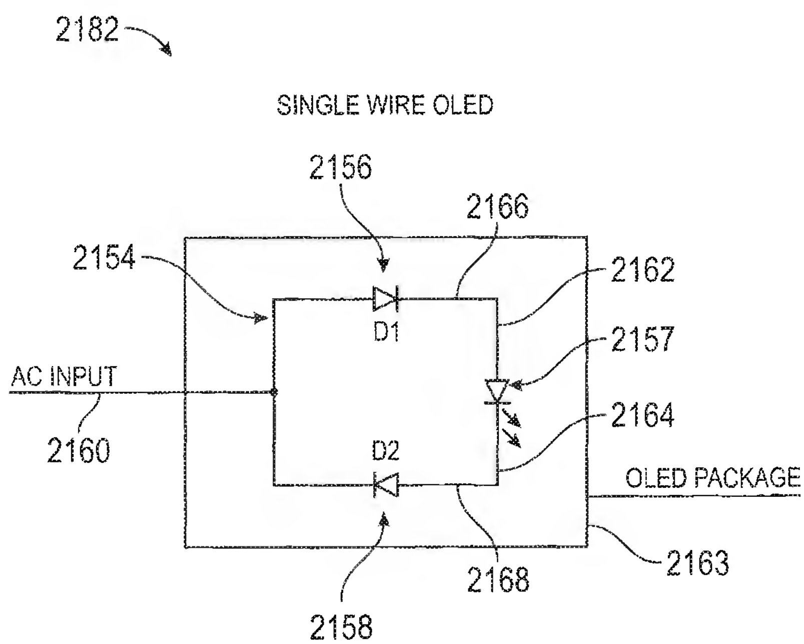


FIG. 61

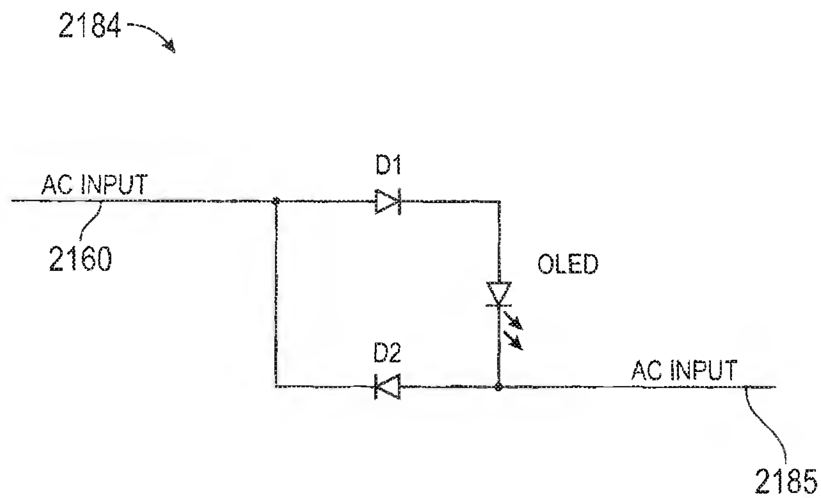


FIG. 62

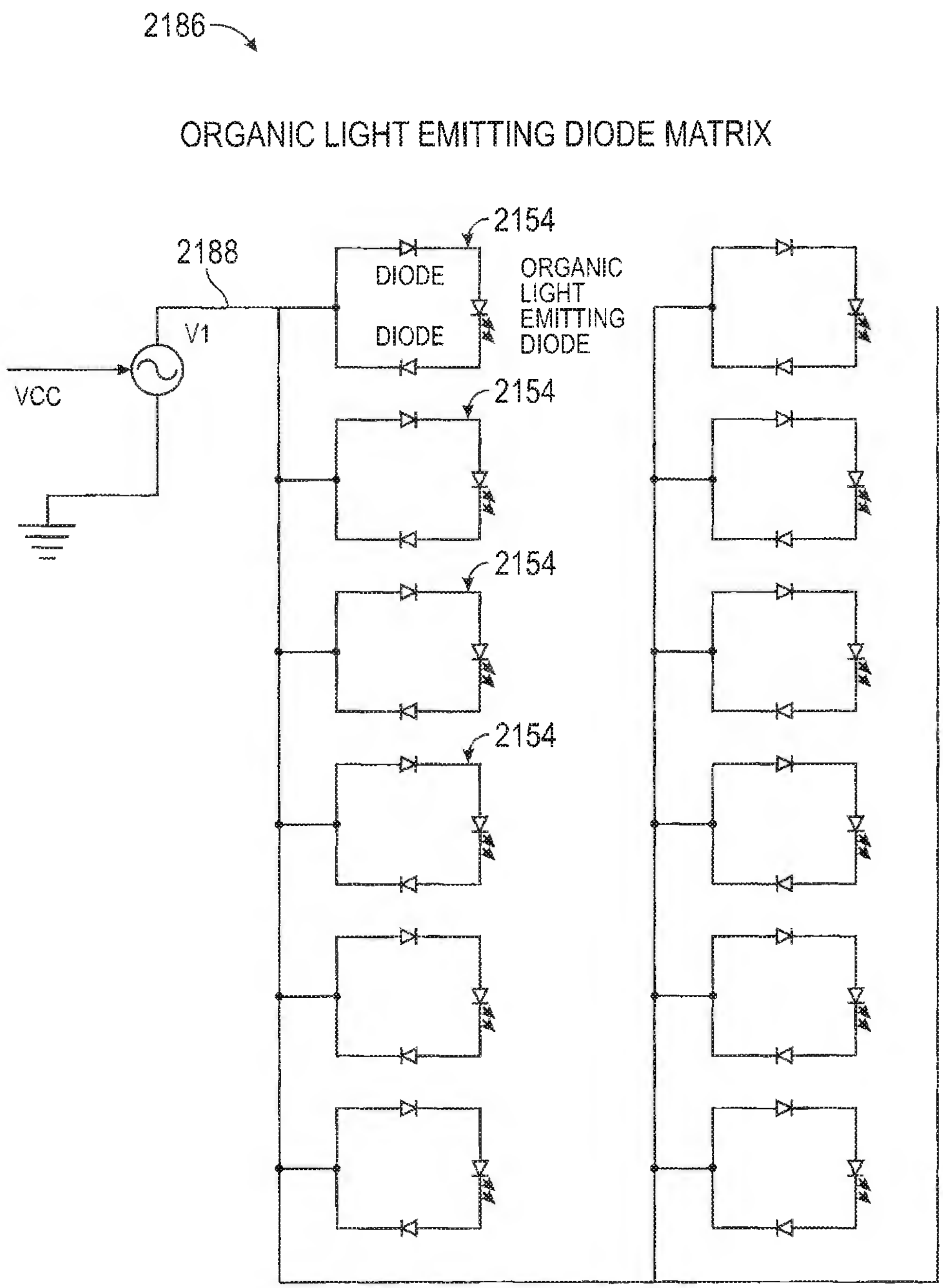

2186
ORGANIC LIGHT EMITTING DIODE MATRIX
2154
2188
DIODE
DIODE
ORGANIC
LIGHT
EMITTING
DIODE
V1
VCC
2154
2154
2154

FIG. 63

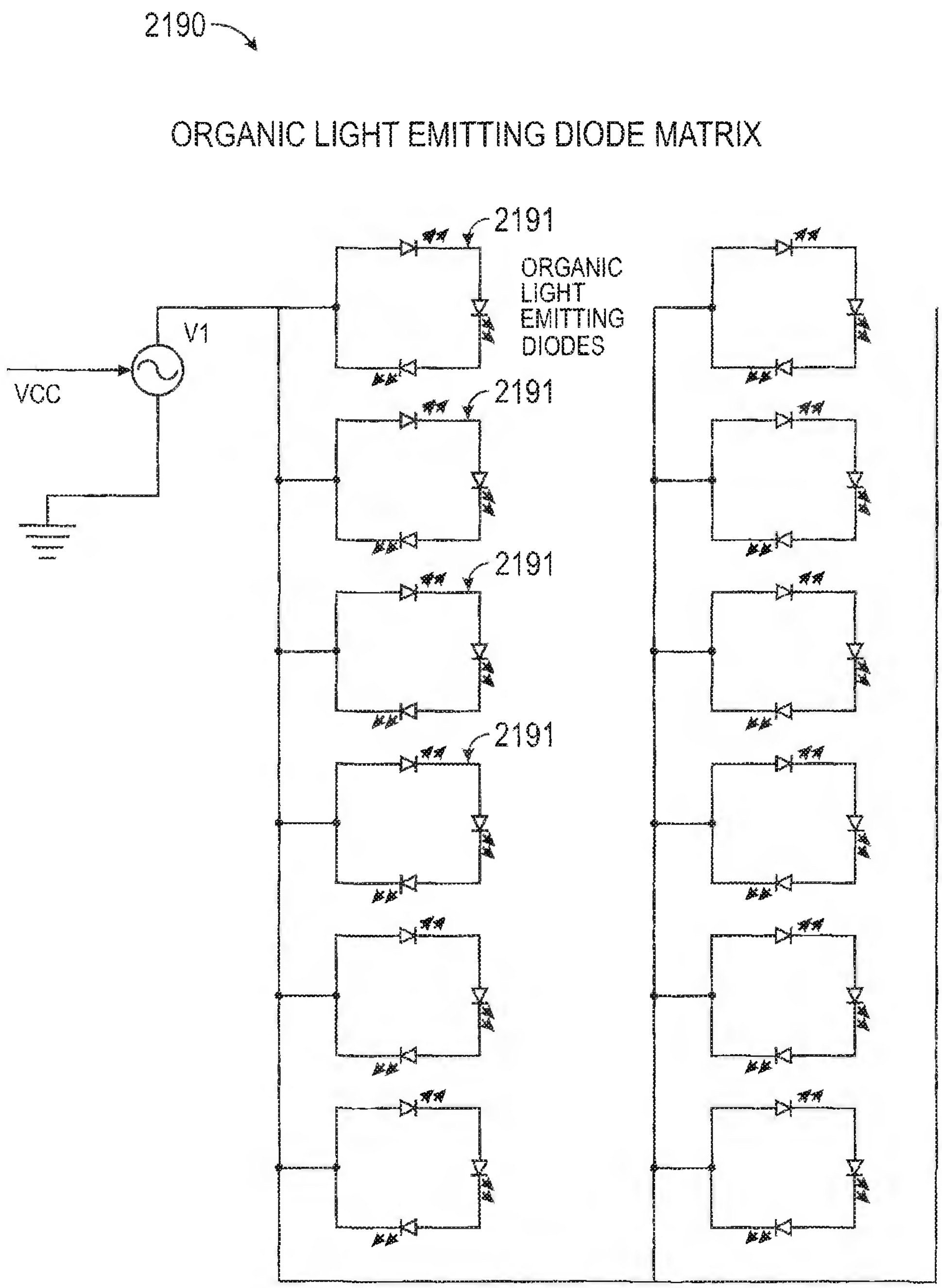

2190
ORGANIC LIGHT EMITTING DIODE MATRIX
2191
ORGANIC LIGHT EMITTING DIODES
V1
VCC
2191
2191
2191

FIG. 64

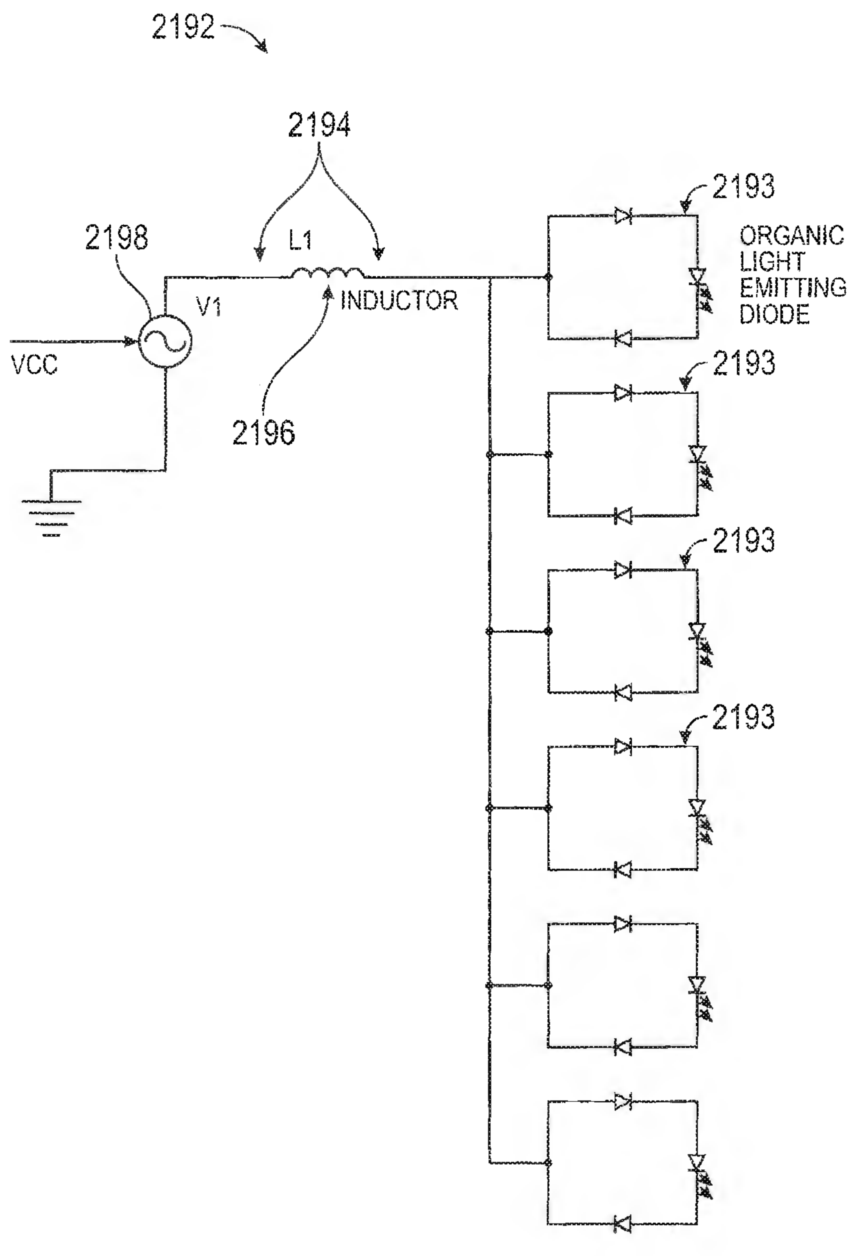

2192
2194
2193
ORGANIC
LIGHT
EMITTING
DIODE
2198
L1
V1
INDUCTOR
VCC
2196
2193
2193
2193

FIG. 65

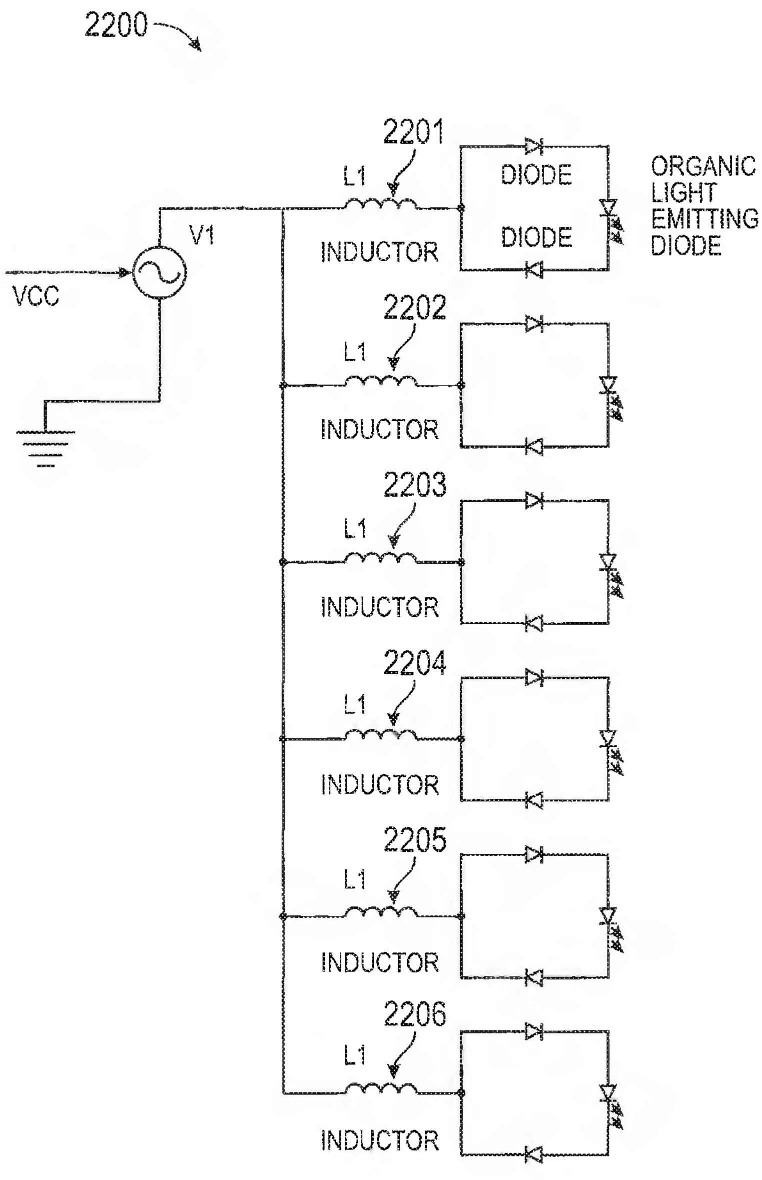
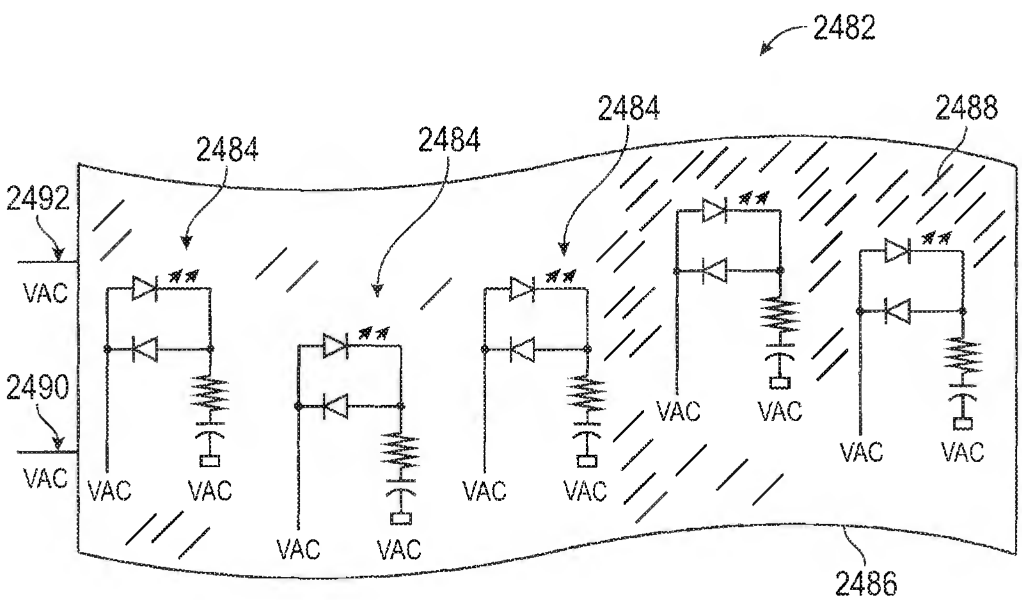

2200
2201
L1
DIODE
ORGANIC
LIGHT
EMITTING
DIODE
V1
DIODE
INDUCTOR
VCC
2202
L1
INDUCTOR
2203
L1
INDUCTOR
2204
L1
INDUCTOR
2205
L1
INDUCTOR
2206
L1
INDUCTOR

FIG. 66



2482
2484
2484
2484
2488
2492
VAC
2490
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
2486

FIG. 67

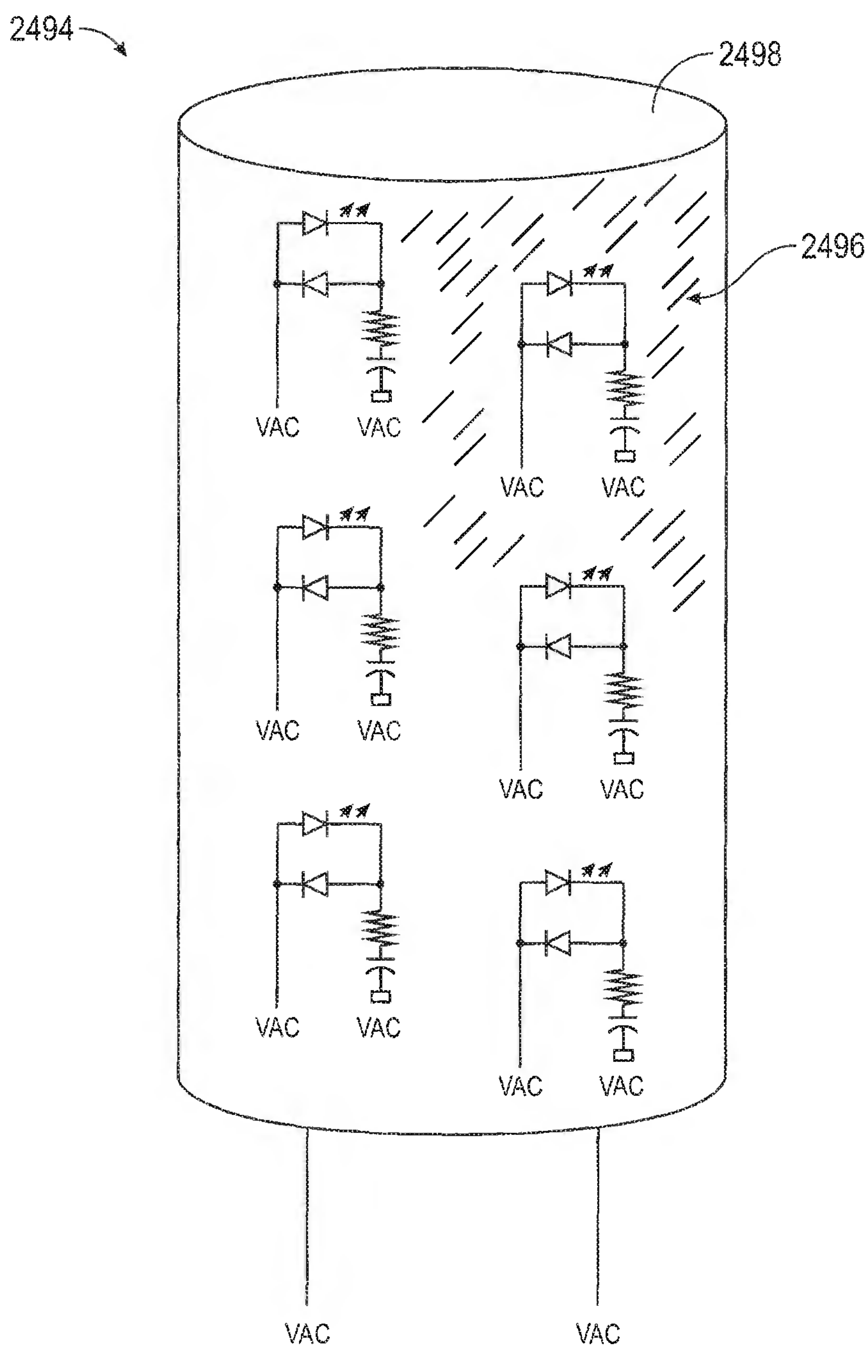

2494
2498
2496
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC
VAC

FIG. 68

AC LIGHT EMITTING DIODE AND AC LED DRIVE METHODS AND APPARATUS

RELATED APPLICATIONS

The present application is a continuation of U.S. patent application Ser. No. 16/693,081 filed Nov. 22, 2019, which is a continuation of U.S. patent application Ser. No. 16/449,273 filed Jun. 21, 2019, which is a continuation of U.S. patent application Ser. No. 16/443,759 filed Jun. 17, 2019, which is a continuation of U.S. patent application Ser. No. 16/407,076 filed May 8, 2019, which is a continuation of U.S. patent application Ser. No. 16/148,945 filed Oct. 1, 2018, which is a continuation of U.S. patent application Ser. No. 15/334,029 filed Oct. 25, 2016, which is continuation-in-part of U.S. patent application Ser. No. 14/948,635 filed Nov. 23, 2015, which is a divisional application of U.S. patent application Ser. No. 13/697,646 filed Nov. 13, 2012 which is a 371 National Phase Application of International Application No. PCT/US2011/0363359 filed May 12, 2011 which claims priority to U.S. Provisional Application No. 61/333,963 filed May 12, 2010 and is a continuation-in-part of International Application No. PCT/US2010/062235 filed Dec. 28, 2010 which claims priority to U.S. Provisional Application No. 61/284,927 filed Dec. 28, 2009 and U.S. Provisional Application No. 61/335,069 filed Dec. 31, 2009 and is a continuation-in-part of U.S. patent application Ser. No. 12/287,267, filed Oct. 6, 2008, which claims priority to U.S. Provisional Application No. 60/997,771, filed Oct. 6, 2007; U.S. patent application Ser. No. 12/364,890 filed Feb. 3, 2009 which is a continuation of U.S. application Ser. No. 11/066,414 (now U.S. Pat. No. 7,489,086) filed Feb. 25, 2005 which claims priority to U.S. Provisional Application No. 60/547,653 filed Feb. 25, 2004 and U.S. Provisional Application No. 60/559,867 filed Apr. 6, 2004; International Application No. PCT/US2010/001597 filed May 28, 2010 which is a continuation-in-part of U.S. application Ser. No. 12/287,267, and claims priority to U.S. Provisional Application No. 61/217,215, filed May 28, 2009; International Application No. PCT/US2010/001269 filed Apr. 30, 2010 which is a continuation-in-part of U.S. application Ser. No. 12/287,267, and claims priority to U.S. Provisional Application No. 61/215,144, filed May 1, 2009; the contents of each of these applications are expressly incorporated herein by reference.

TECHNICAL FIELD

The present invention generally relates to light emitting diodes ("LEDs") and LED drivers. The present invention specifically relates to alternating current ("AC") driven LEDs, LED circuits and AC drive circuits and methods.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

None.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to light emitting diodes ("LEDs") and LED drivers. The present invention specifically relates to alternating current ("AC") driven LEDs, LED circuits and AC drive circuits and methods.

2. Description of the Related Art

LEDs are semiconductor devices that produce light when a current is supplied to them. LEDs are intrinsically DC devices that only pass current in one polarity and historically have been driven by DC voltage sources using resistors, current regulators and voltage regulators to limit the voltage and current delivered to the LED. Some LEDs have resistors built into the LED package providing a higher voltage LED typically driven with 5V DC or 12V DC.

With proper design considerations LEDs may be driven more efficiently with AC than with DC drive schemes. LED based lighting may be used for general lighting, specialty lighting, signs and decoration such as for Christmas tree lighting. For example, U.S. Pat. No. 5,495,147 entitled LED LIGHT STRING SYSTEM to Lanzisera (hereinafter "Lanzisera") and U.S. Pat. No. 4,984,999 entitled STRING OF LIGHTS SPECIFICATION to Leake (hereinafter "Leake") describes different forms of LED based light strings. In both Lanzisera and Leake, exemplary light strings are described employing purely parallel wiring of discrete LED lamps using a step-down transformer and rectifier power conversion scheme. This type of LED light string converts input electrical power, usually assumed to be the common U.S. household power of 110 VAC, to a low voltage, rectified to nearly DC input.

Pat. Pending Application No. 0015968A1 entitled PREFERRED EMBODIMENT TO LED LIGHT STRING to Allen (hereinafter "Allen") discloses AC powered LED-based light strings. Allen describes LED light strings employing series parallel blocks with a voltage matching requirement for direct AC drive placing fundamental restrictions on the number of diodes (LEDs) on each diode series block, depending on the types of diodes used. Allen discloses that for the forward voltage to be "matched," in each series block, the peak input voltage must be less than or equal to the sum of the maximum forward voltages for each series block in order to prevent over-driving.

LEDs can be operated from an AC source more efficiently if they are connected in an "opposing parallel" configuration as shown by WO98/02020 and JP11/330561. More efficient LED lighting systems can be designed using high frequency AC drivers as shown by Patent Publication Number 20030122502 entitled Light Emitting Diode Driver ("Clauberg et. al.") Clauberg et. al. discloses that higher frequency inverters may be used to drive an opposing parallel LED pair, an opposing parallel LED string and/or an opposing parallel LED matrix by coupling the LEDs to a high frequency inverter through a resonant impedance circuit that includes a first capacitor coupled in series to one or more inductors with the impedance circuit coupled in series to opposing parallel LEDs with each set of LEDs having a second series capacitor in series to the impedance circuit. In this system additional opposing parallel configurations of LEDs with capacitors may not be added to or removed from the output of the driver without effecting the lumens output of the previously connected LED circuits unless the driver or components at the driver and/or the opposing parallel LED capacitors were replaced with proper values. By adding or removing the opposing parallel LED circuits the voltage would increase or drop at the inductor and the current would increase or drop through the first series capacitor as the load changed therefore the inductor and all capacitors or entire driver would need to be replaced or adjusted each time additional LEDs were added to or removed from the system.

High frequency AC voltage power supplies and/or transformers can be used to drive LEDs by interfacing a bridge

between the power supply and a DC driven LED circuit(s) or having no bridge between the high frequency transformer and an AC driven LED circuit(s).

High frequency AC transformers can be made smaller and more cost effectively than constant current or constant voltage DC drivers or power supplies currently being used to power LEDs.

The higher the frequency, the smaller the transformer can be made. With proper design consideration and based on the wattage and the frequency of the AC voltage output, a high frequency AC voltage transformer can be made small enough to be mounted directly onto a LED lighting PCB assembly.

Patent application number US2004/0080941 entitled Light Emitting Diodes For High AC Voltage Operation And General Lighting discloses that a plurality of opposing parallel series strings of LEDs can be integrated into a single chip and driven with high voltage low frequency mains AC power sources as long as there are enough LEDs in each opposing parallel series string of LEDs to drop the total source voltage across the series LEDs within the chip. Patent numbers WO2004023568 and JP2004006582 disclose that a plurality of opposing parallel series strings or opposing parallel series matrix of LEDs can be integrated into a single chip and mounted on an insulating substrate and driven with a high drive voltage and low drive current as long as there are enough LEDs in each opposing parallel series string of LEDs to drop the total source voltage across the series LEDs within the chip. These patents and application disclose that for single chip or packaged LED circuits a plurality of opposing parallel series strings are required with the total number of LEDs in each series string needing to be equal to or greater than the AC voltage source in order to drop the total forward voltage and provide the required drive current when driven direct with low frequency AC mains power sources.

The present invention addresses the above-noted shortcomings of the prior art while providing additional benefits and advantages

This invention continues the line of inventions of Nikola Tesla, and Stanislav and Konstantin Avramenko. It is possible to transfer power through one wire, even to operate an electric motor. It is also possible to transfer power without any wires.

The self reference method and device goes one step ahead. For power and signal applications there are benefits in using self referencing circuits and devices without the need to bring extra objects to dissipate the energy already in place or provide a DC return path to ground or an AC power source. With precautions to protect integrated circuits and low power electronic devices, it is possible to design efficient systems when the heat, energy and the error budgets are important. It is also possible to design solid state electric power transformers that can be used in place of magnetic transformers. By reducing the number of connections inside these systems, more efficient designs are possible. It is even conceivable to design portable systems without batteries. DC powered electronic devices require a magnetic transformer and rectification when powered with 120 volt or 240 volt AC power. Additionally, they typically require a drop in supply voltage. A transformer typically reduces the high voltage and rectifies it to DC current. Solid state LED lighting can be powered with AC or DC depending on the design on the device. If rectification is not required, resistors can be used in place of a transformer to drop higher voltages. The resistors generate heat and transformers can be cumbersome as well as generate heat.

One wire electric transmission is due to displacement currents. The dipoles in matter and in the electromagnetic vacuum can move back and forth in the presence of a longitudinal alternating electric field. A positive charge moving in the direction of the electric field contributes equally to the current as a negative charge moving in the opposite direction. There does not have to be a net displacement of charge, from left to right say, to have an electric current. There is no need for a return path.

There is no fundamental need to return all charges to a common dump either. One has to be careful not to produce intense electric fields that break the stability of the material circuits, but beyond that, there is no need to return all charges to a big reservoir like the earth. For portable devices this is a good thing, otherwise they would be impossible to construct. To perform all the tasks required, it is enough to have either real dipoles in material substances, or virtual dipoles in the electromagnetic vacuum. Once the function has been satisfied, the device goes back to the state it had when the process started. Circuits according to the invention have one or more of the following attributes: circulation/symmetry breaking/dipoles; difference of time constant between charge and discharge; AC to DC rectification; tunable load to resonant frequency; frequency/voltage dependence; series inductance; series capacitance; and, an open system harnessing electromagnetic field energy.

SUMMARY OF THE INVENTION

According to one broad aspect of the invention a lighting system is provided having one or more LED circuits. Each LED circuit has at least two diodes connected to each other in opposing parallel relation, wherein at least one of which such diodes is an LED. As used throughout the application, the term diode may mean any type of diode capable of allowing current to pass in a single direction, including but not limited to, a standard diode, a schottky diode, a zener diode, and a current limiting diode. A driver is connected to the one or more LED circuits, the driver providing an AC voltage and current to the one or more LED circuits. The driver and the LED circuits form a driven circuit. The driver and the LED circuits are also configured such that LED circuits may be added to or subtracted (intentionally or by component failure) from the driven circuit:

(a) without significantly affecting the pre-determined desired output range of light from any individual LED; and,

(b) without the need to: (i) change the value of any discrete component; or, (ii) to add or subtract any discrete components, of any of the pre-existing driven circuit components which remain after the change.

In another embodiment of the invention at least one capacitor is connected to and part of each LED circuit. In yet another embodiment, at least one resistor is connected to and is part of each opposing parallel LED circuit noted above. The resistor is connected in series with the at least one capacitor.

According to another aspect of the invention an LED circuit (sometimes referred to as an "AC LED") can comprise two opposing parallel LEDs, an opposing parallel LED string or an opposing parallel LED matrix. These opposing parallel LEDs may have a capacitor in series connected to at least one junction of the connected opposing parallel configurations within a single chip, a single package, an assembly or a module.

When a real capacitor is connected in series in one or more lines between an LED and an AC power source, there is a displacement current through that capacity of magni-

tude: $I=2\Pi fCV$. The capacitor in the LED circuits of the invention regulates the amount of current and forward voltage delivered to the one or more opposing parallel LEDs based on the voltage and frequency provided by the AC driver. Based on the number of LEDs in the LED circuit the opposing parallel connections provide two or more junctions to which at least one series capacitor may be connected in series of at least one power connection lead. In some embodiments, LED circuits may also use a series resistor in addition to the capacitor providing an "RC" resistor capacitor network for certain LED circuit driver coupling that does not provide protection against surge currents to the LED circuits.

According to another aspect of the invention an LED circuit may comprise a single LED or a series string of diodes and/or LEDs connected to a full bridge rectifier capable of rectifying a provided AC voltage and current for use by the series string of diodes and/or LEDs. The rectifier may be formed as part of the LED circuit, or may be formed separately, having leads provided on both the output of the driver and the input of the LED circuit to allow the LED circuit to connect directly to the driver. In order to protect the LED circuit from voltage spikes a capacitor may be connected across the inputs of the bridge rectifier. The capacitor may also be used for smoothing the AC waveform to reduce ripple. A capacitor may likewise be connected between one rectifier input and the AC voltage and current source in order to limit the DC current flow to protect the LEDs. The bridge diode and LED circuit may be packaged separate or together, and may be configured within a single chip or two chips, a single package or two packages, an assembly, or a module.

According to another aspect of the invention, a single bridge rectifier may be used to drive parallel LEDs or series strings of diodes and/or LEDs. Alternatively, it is contemplated by the invention that each LED circuit requiring a bridge rectifier to utilize both the high and low phases of an AC power wave may include its own full bridge rectifier integrated or otherwise connected thereto. In embodiments where each LED circuit includes its own rectifier, additional LED circuits may be added in parallel across an AC voltage and current source to any existing LED circuits without concern of connecting to any existing bridge rectifiers or, where used, capacitors. Providing each LED circuit with its own bridge rectifier has the further advantage of scaling capacitors included in the circuit for voltage protection and/or current limiting to be matched to a particular LED or string of diodes and/or LEDs.

It should be noted that "package" or "packaged" is defined herein as an integrated unit meant to be used as a discrete component in either of the manufacture, assembly, installation, or modification of an LED lighting device or system. Such a package includes LED's of desired characteristics with capacitors and or resistors (when used) sized relative to the specifications of the chosen LED's to which they will be connected in series and with respect to a predetermined AC voltage and frequency.

Preferred embodiments of a package may include an insulating substrate whereon the LEDs, capacitors and/or resistors are formed or mounted. In such preferred embodiments of a package, the substrate will include electrodes or leads for uniform connection of the package to a device or system associated with an AC driver or power source or any individually packaged rectifiers used to rectify AC voltage and current. The electrodes, leads, and uniform connection may include any currently known means including mechanical fit, and/or soldering. The substrate may be such as sapphire, silicon carbide, gallium nitride, ceramics, printed circuit board material, or other materials for hosting circuit components.

A package in certain applications may preferably also include a heat sink, a reflective material, a lens for directing light, phosphor, nano-chrystals or other light changing or enhancing substances. In sum, according to one aspect of the invention, the LED circuits and AC drivers of the present invention permit pre-packaging of the LED portion of a lighting system to be used with standardized drivers (and when necessary full wave rectifiers) of known specified voltage and frequency output. Such packages can be of varied make up and can be combined with each other to create desired systems given the scalable and compatible arrangements possible with, and resulting from, the invention.

According to one aspect of the invention, AC driven LED circuits (or "driven circuits") permit or enable lighting systems where LED circuits may be added to or subtracted (either by choice or by way of a failure of a diode) from the driven circuit without significantly affecting the pre-determined desired output range of light from any individual LED and, without the need to: (i) change the value of any discrete component; or, (ii) to add or subtract any discrete components, of any of the pre-existing driven circuit components which remain after the change. During design of a lighting system, one attribute of the LEDs chosen will be the amount of light provided during operation. In this context, it should be understood that depending on the operating parameters of the driver chosen, the stability or range of the voltage and frequency of the driver will vary from the nominal specification based upon various factors including but not limited to, the addition or subtraction of the LED circuits to which it becomes connected or disconnected. Accordingly, as sometimes referred to herein, drivers according to the invention are described as providing "relatively constant" or "fixed" voltage and frequency. The extent of this relative range may be considered in light of the acceptable range of light output desired from the resulting circuit at the before, during, or after a change has been made to the lighting system as a whole. Thus it will be expected that a pre-determined range of desired light output will be determined within which the driven LED circuits of the invention will perform whether or not additional or different LED circuits have been added or taken out of the driven circuit as a whole or whether additional or different LED circuits have been added proximate any existing LED circuits or positioned remotely.

According to another aspect of the invention an LED circuit may be at least one pre-packaged LED and one pre-packaged diode connected together opposing parallel of each other, two opposing parallel pre-packaged LEDs, an opposing parallel LED string of pre-packaged LEDs, an opposing parallel LED matrix of pre-packaged LEDs optionally having a capacitor in series of at least one junction of the connected LED circuits. It is contemplated that the LED circuit may also be at least one of a single LED or series string of diodes and/or LEDs having a bridge rectifier connected across the single LED or string of diodes. In embodiments where a series string of diodes and/or LEDs and a rectifier is utilized, each LED may likewise be pre-packaged. The rectifier may optionally having a capacitor connected across the rectifier inputs and/or a capacitor connected between to an input of the rectifier for connection between the rectifier and a AC voltage and current source. In either embodiment, utilizing an LED circuit capacitor may allow for direct coupling of at least one LED circuit to the

LED driver without additional series components such as capacitors and/or inductors between the LED circuit driver and the LED circuits. The LED circuit driver provides a relatively fixed voltage and relatively fixed frequency AC output even with changes to the load using feedback AC voltage regulator circuitry. The LED circuit's may be directly coupled and scaled in quantity to the LED circuit driver without affecting the other LED circuit's lumen output as long as the LED circuit driver maintains a relatively fixed voltage and relatively fixed frequency AC output.

According to an aspect of the invention, an LED circuit driver provides a relatively fixed voltage and relatively fixed frequency AC output such as mains power sources. The LED circuit driver output voltage and frequency delivered to the LED circuit may be higher than, lower than, or equal to mains power voltage and frequencies by using an LED circuit inverter driver. The LED circuit inverter driver providing higher frequencies is preferable for LED circuits that are integrated into small form LED packages that include integrated capacitors or resistor capacitor "RC" networks. The LED circuit inverter driver has feedback circuitry such as a resistor divider network or other means allowing it to sense changes to the load and re-adjust the frequency and/or voltage output of the LED circuit driver to a desired relatively fixed value. The LED circuit driver may also provide a soft-start feature that reduces or eliminates any surge current from being delivered to the LED circuit when the LED circuit driver is turned on. Higher frequency and lower voltage LED circuit inverter drivers are preferred enabling smaller package designs of LED circuits as the capacitor at higher frequencies would be reduced in size making it easier to integrate into a single LED circuit chip, package, assembly or module.

According to the invention LED circuits may have a resistor capacitor ("RC") network connected together in series or separate from the LED circuits. The maximum resistor value needed is only that value of resistance needed to protect the one or more LEDs within the LED circuit from surge currents that may be delivered by LED circuit drivers that do not provide soft start or other anti surge current features. Direct mains power coupling would require RC network type LED circuits as the mains power source delivers surge currents when directly coupled to an LED circuit.

The higher frequency LED circuit inverter driver may be a halogen or high intensity discharge (HID) lamp type driver with design modifications for providing a relatively fixed voltage and relatively fixed frequency output as the LED circuit load changes. Meaning if the LED circuit inverter driver is designed to have an output voltage of 12V at a frequency of 50 Khz the LED circuit driver would provide this output as a relatively constant output to a load having one or more than one LED circuits up to the wattage limit of the LED circuit driver even if LED circuits were added to or removed from the output of the LED circuit driver.

The higher frequency inverter having a relatively fixed voltage and relatively fixed frequency output allows for smaller components to be used and provides a known output providing a standard reference High Frequency LED circuit driver enabling LED circuits to be manufactured in volume in existing or reasonably similar LED package sizes with integrated capacitors or RC networks based on the number of LEDs desired in the LED circuit package.

Patent publication number 20030122502 entitled Light Emitting Diode driver (Clauberg and Erhardt) does not disclose the use of a high frequency inverter driver having a means or keeping a relatively fixed voltage and relatively frequency in response to changes in the load. According to the present invention described herein, by not having additional components such as an inductor or capacitor in series between the LED circuit and the LED circuit driver one LED circuit at a time may be added to or removed from the LED circuit driver output without having to change any components, the LED circuit driver or make adjustments to the LED circuit driver. Additionally, according to this invention the lumen output of the existing LED circuits stays relatively constant due to the self-regulating nature of each individual LED circuit when driven with the relatively fixed frequency and voltage of the LED circuit driver. This level of scalability, single chip LED circuit packaging and standardization is not possible with the prior art using an inductor in series between the LEDs or other components due to the voltage or current increase or drop across the inductors and capacitors in response to changes in the load.

Prior art for single chip LED circuits, for example those disclosed in WO2004023568 and JP2004006582 do not provide a way to reduce the number of LEDs within the chip below the total forward voltage drop requirements of the source. The present invention however, enables an LED circuit to be made with any number of LEDs within a single chip, package or module by using, where desired, transformers, capacitors, or RC networks to reduce the number of LEDs needed to as few as one single LED. Improved reliability, integration, product and system scalability and solid state lighting design simplicity may be realized with LED circuits and the LED circuit drivers. Individual LED circuits being the same or different colors, each requiring different forward voltages and currents may be driven from a single source LED circuit driver. Each individual LED circuit can self-regulate current by matching the capacitor or RC network value of the LED circuit to the known relatively fixed voltage and frequency of the LED circuit driver whether the LED circuit driver is a mains power source, a high frequency LED circuit driver or other LED circuit driver capable of providing a relatively fixed voltage and relatively fixed frequency output.

When a real capacitor is connected in series in one or more lines between an LED and an AC power source, there is a displacement current through that capacity of magnitude: $I=2\Pi fCV$. This means that one can predetermine the amount of current to be delivered through a capacitance based upon a known voltage and frequency of an AC source, allowing for each LED circuit containing a series capacitor to have the specific or ideal current required to provide the desired amount of light from the LED circuit.

According to other aspects of the invention, the LED circuit driver may be coupled to a dimmer switch that regulates voltage or frequency or may have integrated circuitry that allows for adjustability of the otherwise relatively fixed voltage and/or relatively fixed frequency output of the LED circuit driver. The LED circuits get brighter as the voltage and/or frequency of the LED circuit driver output is increased to the LED circuits.

One form of the invention is at least one LED and one diode connected together opposing parallel of each other, two opposing parallel LEDs, an opposing parallel LED string and/or opposing parallel LED matrix having a capacitor in series of at least one connected junction of the connected opposing parallel LED configurations within a single chip, a single package, an assembly or a module. When desired, the LED circuit with capacitor may be placed on an insulating substrates such as but not necessarily ceramic or sapphire and/or within various LED package

sizes; materials and designs based of product specifications or assembled on printed circuit board material. Any integrated LED circuit capacitors should be scaled to a predetermined value enabling the LED circuit to self-regulate a reasonably constant and specific current when coupled to an LED circuit driver that provides a relatively fixed voltage and frequency output. Utilized LED circuit capacitors may be of a value needed to provide the typical operating voltage and current of the LED circuit when designed for coupling to a specific LED circuit driver.

Another form of the invention is an LED circuit comprising at least one LED and one diode connected together opposing parallel of each other, two opposing parallel LEDs, an opposing parallel LED string and/or opposing parallel LED matrix having a series resistor capacitor ("RC") network connected together in series or independently in series between at least one connected junction of the opposing parallel LEDs and the respective power connection of the LED circuit. When desired, the opposing parallel LEDs and RC network may be placed on an insulating substrate such as but not necessarily ceramic or sapphire and/or within various LED package sizes; materials and designs based of product specifications or assembled on printed circuit board material. The LED circuit RC network may be of a value needed to provide the typical operating voltage and current of the LED circuit when designed for coupling to a specific LED circuit driver.

Another form of the invention is an LED circuit comprising a matrix of two opposing parallel LEDs connected together in parallel with every two opposing parallel LEDs having an individual capacitor in series to the power source connection if desired. The entire parallel array of opposing parallel LED circuits, including capacitors when used, may be may be placed on an insulating substrate such as but not necessarily ceramic or sapphire and/or within various LED package sizes; materials and designs based of product specifications or assembled on printed circuit board material. The opposing parallel matrix of LED circuits integrated in the LED circuit package may be RC network type LED circuits.

Another form of the invention is an LED circuit comprising a matrix of opposing parallel LEDs connected together in parallel with every set of opposing parallel LEDs having an individual RC network in series to the power connection lead if desired.

Another form of the invention is an LED circuit comprising a matrix of opposing parallel LEDs connected together in parallel, a capacitor connected in series to at least one side of the line going to the matrix of opposing parallel LEDs with every set of opposing parallel LEDs having an individual resistor in series to the power connection if desired.

Yet another form of the invention is an LED circuit comprising opposing parallel series strings of LEDs connected together and driven direct with a high frequency AC voltage equal to or less than to total series voltage drop of the opposing parallel series strings of LEDs within the LED circuit.

Yet another form of the invention is a LED circuit comprising a single LED or a series string of diodes and/or LEDs and a bridge rectifier connected across the LED or string of diodes and/or LEDs. The rectifier may optionally include a capacitor connected across the inputs of the rectifier. The rectifier may additionally, or alternatively, optionally include a capacitor connected in series with one input, the capacitor being capable of connecting the rectifier input to an AC voltage and current source.

Yet another form of the invention is a LED circuit comprising a single LEDs or a series strings of diodes and/or LEDs connected in parallel across the output of a bridge rectifier. The rectifier may optionally include a capacitor connected across the inputs of the rectifier. The rectifier may additionally, or alternatively, optionally include a capacitor connected in series with one input, the capacitor being capable of connecting the rectifier input to an AC voltage and current source.

Another form of the invention comprises a method of driving LED circuits direct from an AC power source ("LED circuit driver") having a relatively fixed voltage and relatively fixed frequency. The LED circuit driver may be a mains power source, the output of a transformer, a generator or an inverter driver that provides a relatively fixed voltage and relatively fixed frequency as the load changes and may be a higher or lower frequency than the frequencies of mains power sources. The LED circuit driver provides a relatively fixed voltage and relatively fixed frequency output even when one or more LED circuits are added to or removed from the output of the LED circuit driver. Higher frequency inverters with lower output voltages are used as one LED circuit driver in order to reduce component size and simplify manufacturing and standardization of LED circuits through the availability of higher frequency LED circuit drivers. The LED circuit driver may also include circuitry that reduces or eliminates surge current offering a soft-start feature by using MOSFET transistors, IGBT transistors or other electronic means. The LED circuit driver may also be pulsed outputs at a higher or lower frequency than the primary frequency.

Another form of the invention is an LED lighting system comprising an LED circuit array having a plurality of different LED circuits each drawing the same or different currents, each having the same or different forward operating voltages, and each delivering the same or different lumen outputs that may be the same or different colors and an LED circuit driver coupled to the LED circuit array. The LED circuit driver delivering a relatively fixed t frequency and voltage output allows for mixing and matching of LED circuits requiring different forward voltages and drive currents. The LED circuits may be connected to the output of an LED circuit driver in parallel one LED circuit at a time within the limit of the wattage rating of the LED circuit driver with no need to change or adjust the LED circuit driver as would typically be required with DC drivers and LEDs when increasing or reducing the load with LEDs and other components. Never having to go back to the power source allows for more efficient integration and scalability of lighting systems designed with LED circuits and allows for a single driver to independently provide power to multiple independently controlled LED circuits in the system. Introducing an inductor and/or an additional capacitor such as the impedance circuit described in prior art between the LED circuit drive source and the LED circuits would require changes to the driver or components and prohibit scalability, standardization and mass production of AC-LEDs with integrated capacitors or RC networks.

With the LED circuit driver providing a known relatively constant AC voltage and frequency, mass production of various LED circuits with specific capacitor or RC network values would deliver 20 mA, 150 mA or 350 mA or any other desired current to the LED circuit based on the output of the specified LED circuit driver. The relatively fixed voltage and frequency allows for standardization of LED circuits through the standardization of LED circuit drivers.

In another aspect, a transistor is coupled to at least one power connection of the LED circuit or built into the LED circuit package in series between the power connection lead and the LED circuit with the transistor being operable to

control (e.g., varying or diverting) the flow of the alternating current through the LED circuit through a capacitance within the transistor.

The foregoing forms as well as other forms, features and advantages of the present invention will become further apparent from the following detailed description of the presently preferred embodiments, read in conjunction with the accompanying drawings. The detailed description and drawings are merely illustrative of the present invention rather than limiting, the scope of the present invention being defined by the appended claims and equivalents thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a schematic view of a preferred embodiment of the invention.

FIG. **2** shows a schematic view of a preferred embodiment of the invention.

FIG. **3** shows a schematic view of a preferred embodiment of the invention.

FIG. **4** shows a schematic view of a preferred embodiment of the invention.

FIG. **5** shows a schematic view of a preferred embodiment of the invention.

FIG. **6** shows a schematic view of a preferred embodiment of the invention.

FIG. **7** shows a schematic view of a preferred embodiment of the invention.

FIG. **8** shows a schematic view of a preferred embodiment of the invention.

FIG. **9** shows a schematic view of a preferred embodiment of the invention.

FIG. **10** shows a schematic view of a preferred embodiment of the invention.

FIG. **11** shows a schematic view of a preferred embodiment of the invention.

FIG. **12** shows a schematic view of a preferred embodiment of the invention.

FIG. **13** shows a schematic view of a preferred embodiment of the invention.

FIG. **14** shows a schematic view of a preferred embodiment of the invention.

FIG. **15** shows a schematic view of a preferred embodiment of the present invention.

FIG. **16** shows a schematic view of a preferred embodiment of the present invention.

FIG. **17** shows a schematic view of a preferred embodiment of the present invention.

FIG. **18** shows a schematic view of a preferred embodiment of the present invention.

FIG. **19** shows a schematic view of a preferred embodiment of the invention.

FIG. **20** shows a schematic view of a preferred embodiment of the invention.

FIG. **21** shows a schematic view of a preferred embodiment of the invention.

FIG. **22** shows a schematic view of a preferred embodiment of the invention.

FIG. **23** shows a schematic view of a preferred embodiment of the invention.

FIG. **24** shows a schematic view of a preferred embodiment of the present invention.

FIG. **25** shows a schematic view of a preferred embodiment of the present invention.

FIG. **26** shows a schematic view of a preferred embodiment of the present invention.

FIG. **27** shows a schematic view of a preferred embodiment of the present invention.

FIG. **28** shows a schematic view of a preferred embodiment of the present invention.

FIG. **29** shows a schematic view of a preferred embodiment of the invention.

FIG. **30**A shows a schematic view of a preferred embodiment of the invention.

FIG. **30**B shows a schematic view of a preferred embodiment of the invention.

FIG. **30**C shows a schematic view of a preferred embodiment of the invention.

FIG. **30**D shows a schematic view of a preferred embodiment of the invention.

FIG. **30**E shows a schematic view of a preferred embodiment of the invention.

FIG. **31** shows a schematic view of a preferred embodiment of the invention.

FIG. **32** shows a schematic view of a preferred embodiment of the invention.

FIG. **33** shows a schematic view of a preferred embodiment of the invention.

FIG. **34** shows a schematic view of a preferred embodiment of the invention.

FIG. **35** shows a schematic view of a preferred embodiment of the invention.

FIG. **36** shows a schematic view of a preferred embodiment of the invention.

FIG. **37** shows a schematic view of a preferred embodiment of the invention.

FIG. **38** shows a schematic view of a preferred embodiment of the invention.

FIG. **39** shows a schematic view of a preferred embodiment of the invention.

FIG. **40** shows a schematic view of a preferred embodiment of the invention.

FIG. **41** shows a schematic view of a preferred embodiment of the invention.

FIG. **42** shows a schematic view of a preferred embodiment of the invention.

FIG. **43** shows a schematic view of a preferred embodiment of the invention.

FIG. **44** shows a schematic view of a preferred embodiment of the invention.

FIG. **45** shows a schematic view of a preferred embodiment of the invention.

FIG. **46** shows a schematic view of a preferred embodiment of the invention.

FIG. **47** shows a schematic view of a preferred embodiment of the invention.

FIG. **48** shows a schematic view of a preferred embodiment of the invention.

FIG. **49** shows a schematic view of a preferred embodiment of the invention.

FIG. **50** shows a schematic view of a preferred embodiment of the invention.

FIG. **51** shows a schematic view of a preferred embodiment of the invention.

FIG. **52** shows a schematic view of a preferred embodiment of the invention.

FIG. **53** shows a schematic view of a preferred embodiment of the invention.

FIG. **54** shows a schematic view of a preferred embodiment of the invention.

FIG. **55** shows a schematic view of a preferred embodiment of the invention.

FIG. **56** shows a schematic view of a preferred embodiment of the invention.

FIG. **57** shows a schematic view of a preferred embodiment of the invention.

FIG. **58** shows a schematic view of a preferred embodiment of the invention.

FIG. **59** shows a schematic view of a preferred embodiment of the invention.

FIG. **60** shows a schematic view of a preferred embodiment of the invention.

FIG. **61** shows a schematic view of a preferred embodiment of the invention.

FIG. **62** shows a schematic view of a preferred embodiment of the invention.

FIG. **63** shows a schematic view of a preferred embodiment of the invention.

FIG. **64** shows a schematic view of a preferred embodiment of the invention.

FIG. **65** shows a schematic view of a preferred embodiment of the invention.

FIG. **66** shows a schematic view of a preferred embodiment of the invention.

FIG. **67** shows a schematic view of a preferred embodiment of the invention.

FIG. **68** shows a schematic view of a preferred embodiment of the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

While this invention is susceptible to embodiments in many different forms, there is described in detail herein, preferred embodiments of the invention with the understanding that the present disclosures are to be considered as exemplifications of the principles of the invention and are not intended to limit the broad aspects of the invention to the embodiments illustrated.

The present invention is directed to an LED light emitting device and LED light system capable of operating during both the positive and negative phase of an AC power supply. In order to operate during both phases provided by an AC power, as is shown herein, the circuit must allow current to flow during both the positive and negative phases and LED light emitting devices may be configured such that at least one LED is capable of emitting light during one or both of the positive or negative phases. In order to accomplish this, the LED circuit itself may be configured so as to allow current to pass during both phases, or the device may include a bridge rectifier to rectify AC power for use by single LEDs, series strings of LEDs, and parallel series strings of LEDs. Rectification may be accomplished within the light emitting device, or prior to any power being provided to the same. Once integrated into a light system, the present invention further contemplates a driver having the ability to provide a substantially constant voltage at a substantially constant frequency, and that the driver be configured in a manner which will allow LED light emitting devices to be added to or subtracted from the system, regardless of configuration, without having to add, subtract, or change the values of discrete circuit components and without affecting the light output of any individual LED.

FIG. **1** discloses a schematic diagram of a light emitting device **10** for an AC driver according to one embodiment of the invention. The device **10** includes a first LED **12** connected to a second LED **14** in opposing parallel configuration, a capacitor **16** connected in series between a first junction **18** of the two opposing parallel LEDs, a first power connection **20** connected to the two opposing parallel LEDs, and a second power connection **22** connected to a second junction **24** of the two opposing parallel connected LEDs. A diode may be used in place of LED **12** or LED **14**.

FIG. **2** discloses a schematic diagram of a light emitting device **26** for an LED circuit driver according to an embodiment of the invention. The device **26** includes the device **10** as disclosed in FIG. **1** mounted on an insulating substrate **28** such as, but not necessarily, ceramic or sapphire, and integrated into an LED package **30** that may be various LED package sizes; materials and designs based of product specifications or on printed circuit board material. The device **26** provides power connection leads **32** and may have a first or additional lens **34** that may be made of a plastic, polymer or other material used for light dispersion and the lens may be coated or doped with a phosphor or nano-particle that would produce a change in the color or quality of light emitted from the device **10** through the lens **34**.

FIG. **3** discloses a schematic diagram of a device **36** having a schematic diagram of the embodiment shown as light emitting device **26** driven directly by an AC driver **38** that is connected to the power connections **32** of the device **26** without any additional components in series between the AC driver **38** and the device **26** such as a capacitor, inductor or resistor. The AC driver **38** provides a relatively constant AC voltage and frequency output to the device **26** no matter what the total load of the device **26** may be, or the number of devices **26** added or subtracted as long as the load does not exceed the wattage limitation of the AC driver **38**. The AC driver **38** may be a generator, a mains power source, or an inverter capable of providing a relatively fixed voltage and relatively fixed frequency output to different size loads. The AC driver may provide a low or high voltage and a low or high frequency to the device **26** according to the invention as long as the capacitor **16** is the proper value for the desired operation of the device **26**.

FIG. **4** discloses a schematic diagram of a light emitting device **40** for coupling to an LED circuit driver according to an embodiment of the invention. The device **40** includes a first LED **42** connected to a second LED **44** in opposing parallel configuration. A capacitor **46** is connected in series between a first junction **48** of the two opposing parallel LEDs and a first power connection **50**. A resistor **52** is connected in series between a second junction **54** of the two opposing parallel LEDs and a second power connection **56**. A diode may be used in place of LED **42** or LED **44** and the resistor **52** may be put in series on either end of the capacitor **46** as an alternate location.

FIG. **5** discloses a schematic diagram of a light emitting device **58** for LED circuit drivers according to an embodiment of the invention. The device **58** includes the device **40** as disclosed in FIG. **4** integrated into a package as disclosed in the device **26** in FIG. **2**. The device **58** provides power connection leads for connecting to an AC driver **38** as disclosed in FIG. **3**.

FIG. **6** discloses a diagram of a light emitting device **64** for coupling to an LED circuit driver according to an embodiment of the invention. The device **64** includes a first series string of LEDs **66** connected to a second series string of LEDs **68** in opposing parallel configuration, a capacitor **70** connected in series between a first junction **72** of the opposing parallel series string of LEDs and a first power connection **74**, and a second power connection **76** connected to a second junction **78** of the opposing parallel series string of LEDs. A diode may be used in place of one or more LEDs **66** and one or more of LEDs **68** and the LEDs **66** and **68** are

integrated into a package **80** as described in the package **30** disclosed in FIG. **2** along with capacitor **70**.

FIG. **7** discloses a diagram of a light emitting device **82** for AC drive according to an embodiment of the invention. The device **82** includes a first series string of LEDs **84** connected to a second series string of LEDs **86** in opposing parallel configuration, a capacitor **88** connected in series between a first junction **90** of the opposing parallel series string of LEDs and a first power connection **92**, and a resistor **94** connected in series between a second junction **96** of the opposing parallel series string of LEDs and a second power connection **98**. A diode may be used in place of one or more LEDs **84** and one or more of LEDs **86** and the LEDs **84** and **86** are integrated into a package **100** as described in the package **30** disclosed in FIG. **2** along with capacitor **88** and resistor **94**. The resistor **94** may be put in series on either end of the capacitor **88** as an alternate location.

FIG. **8** discloses a diagram of a light emitting device **102** according to an embodiment of the invention. The device **102** includes a first series string of LEDs **104** connected to a second series string of LEDs **106** in opposing parallel configuration. A first power connection **108** is connected to a first junction **110** of the opposing parallel series string of LEDs and a second power connection **112** is connected to a second junction **114** of the opposing parallel series string of LEDs. A diode may be used in place of one or more LEDs **104** and one or more of LEDs **106** and the LEDs **104** and **106** are integrated into a package **118** as described in the package **30** disclosed in FIG. **2**.

FIG. **9** discloses a circuit diagram of a light emitting device **120** according to an embodiment of the invention. The device **120** is similar to the device disclosed in FIG. **5** and includes a second series resistor **122** that can be placed in series on either side of the first capacitor **46**.

FIG. **10** discloses a diagram of a light emitting device **124** according to an embodiment of the invention. The device **124** is similar to the device disclosed in FIG. **2** and includes a second series capacitor **126** connected in series between the junction **128** of the opposing parallel LEDs and a power connection **130**.

FIG. **11** discloses a diagram of a light emitting device **130** according to an embodiment of the invention. The device **130** has a matrix of individual light emitting devices **10** as described in FIG. **1** integrated into a package **132** similar to package **30** as described in FIG. **2**.

FIG. **12** discloses a diagram of a light emitting device **134** according to an embodiment of the invention. The device **134** has a matrix of individual light emitting devices **40** as described in FIG. **4** integrated into a package **136** similar to package **30** as described in FIG. **2**.

FIG. **13** discloses a diagram of a light emitting device **138** according to an embodiment of the invention. The device **138** has a matrix of individual sets of 2 opposing parallel light emitting devices **140** with each set having an individual series resistor to connect to a first power connection **140** and a capacitor **146** connected in series between a second power connection and the matrix of devices **140**. The capacitor **146** may alternately be in series between the first power connection **144** and all resistors **142**. The matrix of devices **140**, resistors **142** and capacitor **146** are integrated into a package **150** similar to package **30** as described in FIG. **2**.

FIG. **14** discloses a diagram of a light emitting device **152** according to an embodiment of the invention. The device **152** includes another version of a series opposing parallel LED matrix **154** and a capacitor **156** connected in series between a first junction **158** of the opposing parallel LED matrix **154** and a first power connection, and a second power connection **162** connected to a second junction **164** of the opposing parallel LED matrix. A first power connection **108** is connected to a first junction **110** of the opposing parallel series string of LEDs and a second power connection **112** is connected to a second junction **114** of the opposing parallel series string of LEDs. A diode may be used in place of one or more LEDs **104** and one or more of LEDs **106** and the LEDs **104** and **106** are integrated into a package **118** as described in the package **30** disclosed in FIG. **2**.

FIG. **15** discloses a schematic diagram of a light emitting device **300** according to an embodiment of the invention. Device **300** includes bridge rectifier circuit **302** having diodes **304*a*-304*d*** with at least one LED connected across the output of the rectifier circuit, shown as LED **306**. While inputs **308** and **310** of the bridge rectifier may be provided for direct connection to an AC power supply, it is contemplated by the invention that one input, shown as input **310**. may have a capacitor (shown as capacitor **312**) or a resistor (shown in FIG. **18** as resistor **313**) connected in series in order to control and limit the current passing through the at least one LED. Additionally, capacitor **314** may be connected across the rectifier inputs to protect against voltage spikes.

FIGS. **16** and **18** each disclose a schematic diagram of a light emitting device **316** and **332** for an LED circuit driver according to an embodiment of the invention. The device **316** includes the device **300** as disclosed in FIG. **15** (with additional LEDs **306** added in series) mounted on an insulating substrate **318** such as, but not necessarily, ceramic or sapphire, and forming an LED package **320** that may be various sizes; materials and designs based of product specifications or on printed circuit board material. As shown in FIG. **16**, The device **316**, **332** provides power connection leads **322** and **323** and may have a first or additional lens that may be made of a plastic, polymer or other material used for light dispersion and the lens may be coated or doped with a phosphor or nano-particle that would produce a change in the color or quality of light emitted from device **300** through the lens. LED package **320** may include rectifier **302** to drive LEDs **306**. Rectifier **306** may be mounted on insulating substrate **318** along with any LEDs. As should be appreciated by those having ordinary skill in the art, it is contemplated by the invention that any diode or LED may be swapped for the other within the package so long as the package includes at least one LED to emit light when in operation. Any capacitors **312**, **314** or resistors **313** included in the light emitting devices may like wise be mounted on substrate **318** and included in LED package **320**.

Rather than be packaged together and mounted on a single substrate, and no matter whether the LEDs and diodes are integrated into a single package or are discrete individual LEDs and/or diodes wire-bonded together, as disclosed in FIG. **17** rectifier **302** may be discretely packaged separate from any discrete LED packages **324** where discrete LED package **324** includes one LED **306** or multiple LEDs connected in series or parallel. Rectifier **302** may be packaged into rectifier package **326** for plug and use into a light system, or alternatively may be included as part of a driver used to drive the series LEDs. When packaged separate, package **326** may be provided with input power connections **328** and **329** which to connect the inputs of the rectifier to an AC power supply. In order to connect to one (or more) single or series LEDs and provide power thereto, package **326** may also be provided with output power connections **330** and **331** which may connect to LED package inputs **334** and **335**. Any capacitors **312**, **314** or resistors **313** included

in the light emitting devices may like wise be mounted on substrate **316** and included in rectifier package **326**.

Regardless of whether rectifier **302** and LEDs **306** are integrated or mounted in a single package or are discretely packaged and connected, in order to drop higher voltages any number of LEDs may be connected in series or parallel in a device to match a desired voltage and light output. For example, in a lighting device that is run off of a 120 V source and contains LEDs having a forward operating voltage of 3V each connected to a bridge rectifier having diodes also having a forward operating voltage of 3V each, approximately 38 LEDs may be placed in series to drop the required voltage.

FIG. **19** discloses an embodiment of an LED lighting device encapsulated in a housing. As shown in FIG. **19**, LED device **336** may include a housing **338** encapsulating at least one bridge rectifier **340**, at least one LED circuit **342** connected across the output of the bridge rectifier. Device **334** includes first power connection lead connected **344** to a first input of the rectifier **346** and a second power connection lead **348** connected to a second input of the rectifier **350**. At least a portion of each power connection is contained within the housing while at least a portion of each power connection extends beyond the housing to allow device **336** to connect to an AC power source. Rectifier **340** and LED circuit **342** may be connected, assembled, and/or packaged within housing **336** using any of the methods described in conjunction with FIGS. **15-18** or any other means known in the art. It should be appreciated by those having ordinary skill in the art that the devices and packages described in FIGS. **2**, **3**, and **5-14** may likewise incorporate a housing to encapsulate any device and/or package therein.

FIG. **20** discloses a schematic diagram of a lighting system **168** according to an embodiment of the invention. The device **168** includes a plurality of devices **26** as described in FIG. **2** connected to a high frequency inverter AC drive Method **170** as described in FIG. **3** which in this example provides a relatively constant 12V AC source at a relatively constant frequency of 50 Khz to the devices **26**. Each or some of the devices **26** may have integrated capacitors **172** of equal or different values enabling the devices **26** to operate at different drive currents **174** from a single source AC drive Method.

FIG. **21** discloses a schematic diagram of a lighting system **176** according to an embodiment of the invention. The lighting system **176** includes a plurality of devices **178**, **180** and **182** each able to have operate at different currents and lumens output while connected directly to the transformer **184** output of a fixed high frequency AC drive Method **186**.

Any of the aforementioned AC drive methods may likewise be used with the devices embodied in FIGS. **15-19**.

For example, FIG. **22** discloses a schematic diagram of a lighting system **400** according to an embodiment of the invention. System **400** includes a plurality of devices **316**, **332** as described in FIGS. **16** and **18** connected to a high frequency inverter AC drive Method **170** similar to that described in FIGS. **3** and **20** which provides a relatively constant 12V AC source at a relatively constant frequency of 50 Khz to the devices **316**, **332**. Each or some of the devices **316**, **332** may have integrated capacitors **312**, **314** and resistors **313** of equal or different values enabling the devices **300** to operate at different drive currents from a single source AC drive Method. As should be appreciated by those having ordinary skill in the art, while the example of 12V AC at 50 Khz is given herein, it is contemplated by the invention that any voltage at substantially any frequency

may be provided by the driver by utilizing a proper transformer and/or inverter circuit.

Similarly, AC drive Method **186** may be utilized may be used with a single or plurality of devices **214** as disclosed in FIG. **23**. As with the embodiment shown in FIG. **21**, each device **316**, **332** may be connected directly to transformer **184** output to receive a substantially fixed frequency voltage.

FIG. **24** discloses an embodiment of the invention where AC drive Method **186** is provided to a rectifier and LED series strings are discretely packaged. As previously disclosed, rectifier **302** may be discretely packaged in a rectifier package **326**, separate from both AC drive Method **186** (or alternatively AC drive Method **170**) and discrete LED packages **324**, or alternatively may be included in AC drive Method **186**.

FIG. **25** discloses another schematic view diagram of a light emitting device **188** identical to the device **130** disclosed in FIG. **11** and integrated into a package **30** as described in FIG. **2** for an AC drive Method according to an embodiment of the invention. The device **188** includes the device **130** as disclosed in FIG. **11** mounted on an insulating substrate **28** such as but not necessarily ceramic or sapphire and integrated into an LED package **30** that may be various LED package sizes; materials and designs based of product specifications or on printed circuit board material. The device **188** provides power connection leads **190** and **192** and may have a first or additional lens **194** that may be made of a plastic, polymer or other material used for light dispersion and the lens may be coated or doped with a phosphor or nano-crystals that would produce a change in the color or quality of light emitted from the device **130** through the lens **194**. The device **130** has a matrix of devices **10**. The power connection opposite the capacitors **16** within the device **130** and part of each device **10** is connected to a power connection **196** that is connected to a solderable heat sinking material **198** and integrated into the package **30**. The power connection **196** connected to the heat sink **198** may be of a heavier gauge within the device **130** or **188** than other conductors. The schematic view of the device **188** provides a side view of the package **30** and an overhead view of the device **130** in this FIG. **25**.

FIG. **26** discloses another schematic view diagram of a light emitting device **198** similar to the device **188** described in FIG. **25** with a different light emitting device **200** identical to the device **136** disclosed in FIG. **12** and integrated into a package **30** as described in FIG. **2** for an AC drive Method according to an embodiment of the invention. The device **198** includes a reflective device integrated into the package **30** for optimized light dispersion. The light emitting device **200** may be facing down towards the reflector **202** and opposite direction of light output from the lens **194** if the reflector **202** is integrated into the package **30** properly for such a design.

FIG. **27** discloses another schematic view diagram of a light emitting device **500** similar to that shown in FIG. **24** according to an embodiment of the invention. The device **500** includes the devices **316**, **332** similar to those disclosed in FIGS. **16** and **18**, mounted on an insulating substrate **318** such as but not necessarily ceramic or sapphire and integrated into an LED package **320** that may be various LED package sizes; materials and designs based of product specifications or on printed circuit board material. The device **500** provides power connection leads **502** and **503** which connect to package power connect leads **322** and **323** and may have a first or additional lens **504** that may be made of a plastic, polymer or other material used for light dispersion and the

lens may be coated or doped with a phosphor or nanocrystals that would produce a change in the color or quality of light emitted from the device through the lens **504**. Power connection **322** may be connected to heat sink **506** and may be of a heavier gauge within the device than other conductors.

FIG. **28** discloses another schematic view diagram of a light emitting device **508** similar to that shown in FIG. **26**. Device **508** is contemplated for use in embodiments where the rectifier is discretely packaged or included as part of AC drive Method **170** or **186**. In device **508**, power connection leads **510** and **511** connect to the outputs of rectifier **302** (not shown) to provide power to LED packages **324**.

FIG. **29** shows a block diagram of an LED circuit driver **204** having a high frequency inverter **206** stage that provides a relatively constant voltage and relatively constant frequency output. The high frequency inverter **206** stage has an internal dual half bridge driver with an internal or external voltage controlled oscillator that can be set to a voltage that fixes the frequency. A resistor or center tapped series resistor diode network within the high frequency inverter **206** stage feeds back a voltage signal to the set terminal input of the oscillator. An AC regulator **208** senses changes to the load at the output lines **210** and **212** of the inverter **206** and feeds back a voltage signal to the inverter **208** in response changes in the load which makes adjustments accordingly to maintain a relatively constant voltage output with the relatively constant frequency output.

FIG. **30** shows a schematic diagram of an LED circuit driver **214** having a voltage source stage **216**, a fixed/adjustable frequency stage **218**, an AC voltage regulator and measurement stage **220**, an AC level response control stage **222**, an AC regulator output control stage **224** and a driver output stage **226**.

FIG. **31** shows a schematic diagram of the voltage source stage **216** described in FIG. **20**. The voltage source stage **216** provides universal AC mains inputs **228** that drive a diode bridge **230** used to deliver DC to the LED circuit driver system **214**. Direct DC could eliminate the need for the universal AC input **228**. Power factor correction means **232** may be integrated into the LED circuit driver **216** as part of the circuit. The voltage source stage **216** includes a low voltage source circuit **234** that may include more than one voltage and polarity.

FIG. **32** shows a schematic diagram of the fixed/adjustable frequency stage **218** as described in FIG. **20**. The fixed/adjustable frequency stage **218** includes a bridge driver **236** that may include an integrated or external voltage controlled oscillator **238**. The oscillator **238** has a set input pin **240** that sets the frequency of the oscillator to a fixed frequency through the use of a resistor or adjustable resistor **242** to ground. The adjustable resistor **242** allows for adjusting the fixed frequency to a different desired value through manual or digital control but keeps the frequency relatively constant based on the voltage at the set terminal **240**.

FIG. **33** is a schematic diagram of the AC voltage regulator with voltage measurement stage **220** as described in FIG. **20**. The AC voltage regulator with voltage measurement circuit **220** monitors the voltage at the driver output **226** as shown in FIG. **20** and sends a voltage level signal to the AC level response control stage **222** as shown in FIG. **20**.

FIG. **34** is a schematic diagram of the AC level response control **228** stage. The AC level response control stage **228** receives a voltage level signal from the AC voltage regulator with voltage measurement circuit **220** as shown in FIG. **23** and drives the AC regulator output control stage **224** as shown in FIG. **20**.

FIG. **35** is a schematic diagram of the AC regulator output control stage **230**. The AC regulator output control stage **230** varies the resistance between the junction of the drive transistors **232** and the transformer input pin **234** of the driver output **226** as shown in FIG. **26**. The AC regulator output control stage **230** is a circuit or component such as but not necessarily a transistor, a voltage dependent resistor or a current dependent resistor circuit having a means of varying its resistance in response to the voltage or current delivered to it.

FIG. **36** is a schematic diagram of the driver output stage **226**. The driver output stage **226** includes drive transistors **232** and the transformer **236** that delivers an AC voltage output **238** to LED circuits at a relatively constant voltage and frequency.

FIGS. **37** and **38** discloses a circuit **1104** to illustrate another aspect of the invention. Accordingly, an alternating electric field is provided to a first transmission conductor by a signal generator **1102** and a second transmission conductor is provided by an antenna **1108** (see FIG. **37**) or wire **1124** (see FIG. **38**) that is connected to a relatively less positive side **1114**-**1122** within the directional circuit **1110**. A difference in DC potential between a relatively more positive side **1112** within the directional circuit, and relatively less positive side **1114**-**1122** is provided. Another aspect of the invention is sensing proximity with impedance changes within the directional circuits described herein (as it could be with any embodiment disclosed herein) by approaching any of the directional circuits or transmission conductors (also any of which are described herein), for example approaching **1108** (shown in FIG. **37**) and/or **1124** (as shown in FIG. **38**) with a conductive substance such as a person, including the touch of a person (human touch), or metallic material thereby changing the circulation of current flow within the directional circuit by changes in impedance through the capacitance of the conductive substance.

FIGS. **39**, and **40**-**41** disclose another embodiment of the invention having a directional organic light emitting diode ("OLEO") circuit **1154** that includes a first diode D**1** **1156**, a second diode D**2** **1158**, and an OLED **1157**. The first diode D**1** **1156** has an anode and the second diode D**2** **1158** has a cathode, which are commonly connected to a input transmission conductor **1160**. The cathode of diode D**1** **1156** is connected to the relatively more positive side **1162** anode of an OLED **1157** while the anode of diode D**2** **11** is connected to the relatively less positive side cathode **1164** of the OLED **1157** to form the loop circuit **1154** among the diodes D**1**, D**2** and the OLED **1157**. The directional OLEO circuit **154** is a loop circuit which includes one or more circuit elements (e.g. diodes or OLEDs **1156**, **1157** and **1158**) causing the loop circuit to be asymmetric to current flow. Circuit element **1157** is an OLED. The directional OLEO circuit **1154** does not have a continuous conductive path to earth ground, or battery ground. The directional OLEO circuit **1154** develops a DC potential in response to a alternating electric field imposed on input **1160**. The directional OLEO circuit **1154** is self referencing between a relatively high potential output and a relatively lower potential output. The directional OLEO circuit **1154** has a resistance, inductance and capacitance that is responsive to the voltage and frequency of the alternating electric field. The directional OLEO circuit **1154** has transmission conductors **1166**,**1168** connected to the directional OLEO circuit **1154**.

FIG. **40** discloses a circuit **1182** with the same embodiment of the invention shown in FIG. **39** (see FIG. **39**) encasing the directional OLEO circuit **1154** within a package **1163**.

FIG. **41** discloses a circuit **1184** with the same embodiment of the invention shown in FIG. **39** (see FIG. **39**) with a second transmission conductor **1185** providing an input within the directional circuit **1184** at a point other than the input of the first transmission conductor input of **1160**. The transmission conductors **1160** and **1185** (or any transmission conductors described herein) can act as an antenna and cause the directional OLEO circuit **1184** to react to the proximity of conductive substances near the transmission conductors **1160** and **1185**. In preferred embodiments, the circuits disclosed in FIGS. **39-41** and **43** below may be connected to ground through capacitance at a point within the directional circuit such as transmission conductor **1185** (e.g. FIG. **41**). This ground connection seems to provide increased circulation current, as it is noted that the OLEDs get brighter for a given alternating electromagnetic source.

FIG. **42** discloses a circuit **1226** identical to circuit **1210** but that the circuit has a first transmission conductor **1228** and a second transmission conductor **1230**. Each transmission conductor **1228**,**230** can be driven with an alternating electric field and can cause the circuit **1226** to react to the proximity of a conductive substance that approaches the transmission conductors **1228** and **1230** with only one or both conductors being driven.

FIG. **43** discloses another embodiment of the invention having a directional organic light emitting diode ("OLEO") circuit **1170** that includes a first OLEO **1172**, a second OLEO **1174**, and a third OLEO **1176**. The first OLEO **1172** has an anode and the third OLEO **1176** has a cathode, which are commonly connected to an input transmission conductor **1178** having AC signal source from a signal generator **1180**. The cathode of the first OLEO **1172** is connected to the anode of the second OLEO **1174** while the cathode of the second OLEO **1174** is connected to the anode of the third OLEO **1176** to form the loop circuit **1170** among the OLEDs **1**, **2** and **3** (**1172-1176**). The directional OLEO circuit **1170** can be designed with more than 3 OLEDs.

FIG. **44** discloses a preferred circuit **2010** according to the invention. The circuit **2010** includes a first source for providing an alternating electric field. The source may be 120V or 240V line power, RF energy or the output of a standard AC signal generator such as generator **2012** of FIG. **44**. This generator **2012** may produce its signal with reference to ground as indicated in FIG. **44**. Circuit **2010** also discloses a directional circuit **2014** connected to the generator **2012** by a transmission conductor **2016**. According to the invention the conductor **2016** may be any form of conventional conductive path whether twisted wire bundles, single wires, etc. The point is that the transmission conductor **2016** provides a single transmission path to the directional circuit **2014**. Important to the invention is the fact that there is no conductive return path provided back from the directional circuit **2016** to the generator **2012**.

In the broad sense, the directional circuit **2014** is a loop circuit which includes one or more circuit elements causing the loop circuit to be asymmetric to current flow. Again it is important that the directional circuit **2014** has no continuous conductive path to earth ground, or a battery ground. As such, and as disclosed in FIG. **44** the directional circuit **2014** develops a DC potential across a load, such as resistor R1 in response to the alternating electric field. This DC potential is not referenced to ground but merely to the potential differences created by the circulation of current (see FIG. **45**) in the loop across the load (resistor R1 of FIG. **44**). Accordingly, the DC potential is self referencing. As far as the resistor R1 is concerned, circuit **2010** presents it with a

relatively higher DC potential output at **2020** and a relatively lower potential output at **2022**.

FIG. **45** discloses circuit **2010** with the load represented as a generic load **2024** (rather than resistor R1) to show the circulation path of current flow (indicated by the arrows) in any generic load circuit utilizing the DC potential of circuit **2010**.

FIGS. **44** and **45** disclose that the loads connected to the directional circuit **2014** do not have a continuous conductive path to earth ground or a battery ground. They also disclose that the directional circuit **2014** has circuit elements causing the directional circuit to be asymmetric to current flow. In the preferred embodiment disclosed, these circuit elements are diodes D1 and D2. However, it is contemplated that numerous other circuit elements could provide the same functionality, in particular, semiconductors with "pn" junctions; electrets, plasma, organic; or combinations thereof.

The circuit **2010** is preferably used for delivering power and sensing proximity. The circuit **2010** is also preferably useful in TTL logic applications as disclosed in FIG. **46** showing a standard TTL logic output circuit **2026** powered by circuit **2010**. In that application, the DC voltages necessary range from 0V to +/−5V.

FIGS. **44-46** each disclose that directional circuit **2014** includes first and second diodes D1 and D2, with D1 having an anode and diode D2 having a cathode which are commonly connected to the transmission conductor **2016**. the cathode of the first diode D1 is connected to the relatively more positive side of the load **2020** while the anode of the second diode is connected to the relatively less positive side load **2022** to form the directional loop circuit among the diodes and the load.

FIG. **47** discloses a circuit **2024** according to the invention having a standard AC signal generator **2026** and a directional circuit **2028** includes first and second light emitting diodes (LEDs), the first LED **1** has an anode and the second LED **2** has a cathode, which are commonly connected to the conductor **2030** from the generator **2026**. The cathode of LED **1** is connected to the relatively more positive voltage side **2032** of the load **2036** while the anode of LED **2** is connected to the relatively less positive side **2034** of the load **2036** to form the loop circuit **2028** among the LEDs **1** and **2**. In this embodiment the load is configured to optimize the lumen produced by the directional circuit, for example the LEDs **1**, **2** used to deliver power to the load **2036** which can be a third LED as shown in FIG. **48**.

FIG. **48** discloses a circuit **2038** according to the invention. In this embodiment, a generator **2040** produces an alternating electric field on transmission conductor **2040**. The conductor **2041** is connected to a directional circuit **2042** having circuit elements causing an asymmetrical response to the alternating field and current flow. In particular, circuit **2042** includes three LEDs **1**, **2**, **3**, configured to provide circulation according to the direction of the arrows (see FIG. **48**). In this embodiment, all three LEDs **1-3** provide light as an output that can be considered as a load. This shows that relative nature of the positioning of elements in the various directional circuits disclosed herein according to the invention. If light is desired, then each of the diodes may be considered both loads and circuit elements which cause asymmetrical current flow. For example, FIG. **49** discloses the same circuit **2038** with only the substitution of LEDs **1** and **3** by diodes D1 and D2. In this circuit, optimization of the light emitted by LED **2** is of paramount concern, whereas the diodes **1**, **2** provide directionality and a DC offset to the AC signal source as will be disclosed in more detail below. In preferred embodiments,

the directional circuits, including directional circuit **2014**, disclosed herein throughout this invention may be connected to ground through capacitance **2039** at a point within the directional circuit other than the AC signal input point **40** as shown in FIG. **49**. This ground connection seems to provide increased circulation current, as it is noted that the LEDs get brighter for a given alternating electromagnetic source. The capacitor **2039** may alternatively be placed on the other side of the AC line **2041**. The capacitor is used to drop the voltage from the AC source.

FIG. **50** discloses a circuit **2042** having an AC signal generator **2044** inducing an alternating electric field onto transmission conductor **2046** which is connected to a first directional circuit **2048** having LEDs **1-3**. LED **2** acting as a load to circuit **2048**, provides the relatively high DC potential at point **2050** and a relatively lower DC potential at point **2052** to another directional circuit **2054** comprised of LEDs **4-6**. This is repeated for another directional circuit **2056** and LEDs **7-9**. Again, the circuit components LEDs **1-9** provide both directionality and useful work as a load in the form of producing light. According to another aspect of the invention, the circuit **2042** discloses the multiplexing possibilities of the directional circuits **2048**, **2052**, **2056**. According to another aspect of the invention, the circuit **2042** discloses a parallel LED directional circuit.

FIG. **51** discloses a circuit **2058** to illustrate another aspect of the invention, in particular the transmission of information or data as one may use the terms. Accordingly, the alternating electric field is provided (as it could be with any embodiment disclosed herein) by either an antenna **2060** or a signal generator **2061**. The alternating signal source is imposed on transmission conductor **2062**. A directional circuit **2064** is comprised of a load **2066** and two diodes D1 and D2. The circuit **2058** discloses the directional DC current flow as well as an AC plus DC current flow and potential indicated by "AC+DC" in FIG. **51**. This DC plus AC component is important to the transmission of information or data signals from the generators **2060**, **2061**.

In particular, FIG. **52** discloses a circuit **2068** having a signal generator **2070**, a transmission conductor **2072**, and a directional circuit **2074**. The directional circuit has asymmetrical diode elements D1 and D2 and a load R1. In this and the other embodiment disclosed herein (see FIG. **51**), the directional circuit **2074** is constructed to permit a DC voltage level to accrue on the transmission conductor **2072** along with the AC signal to provide an offset to the signal. This offset is preferential to the signal as the signal is ungrounded. It is believed that this may prevent noise in the system to be added to the line **2072** as a second alternating field but with reference to ground. Accordingly the noise adds to the DC level but not to the signal level in the same proportions.

Also as disclosed in FIG. **52**, an output **2076** is provided which will transmit the AC signals from transmission line **2072** to an information or data signal receiver **2078** which will detect the signal riding the DC level. The DC level can easily be distinguished and handled by such a receiver as is conventional. It should be understood that the signal receiver **2078** may be of any conventional type of TTL logic device, modem, or telecommunications receiver and is believed to operate best with the preferred systems of the invention when it is not connected to earth ground or a battery ground, or a current sink or charge collector (as is the case for the working loads disclosed through out this disclosure).

According to another embodiment, FIG. **53** discloses another information or data communication circuit **2080**. The circuit **2080** includes a signal generator **2082**, a transmission conductor **2084**, a directional circuit **2086**, a data receiver **2088**, and a ground switch **2090**. In this embodiment, the directional circuit **2086** provides both the DC power for the receiver **2088**, and a data signal through output **2092** connected between the receiver input and the common connection between the conductor **2084** and directional circuit input to anode of diode D1 and cathode D2. In the meantime, the receiver is powered on the DC potential difference between D1 the relatively more positive side **2094** and D2 the relatively less positive side **2096** of the directional circuit. In this embodiment, resistor R1 is provided according to another aspect of the invention to regulate or select as desired the level of DC offset the AC data signal will have at line **2092**.

According to another aspect of the invention, the ground switch **2090** is provided to provide a non-continuous connection to a circuit, such as the ground circuit disclosed in FIG. **53**, to dissipate excessive accumulations of charge or voltage potentials in the circuit **2080**. It is contemplated that the switch **2090** be actuated based upon a timing (such as a pre-selected clock pulse) criteria, or by a sensor (not shown) of an undesirable DC level developing in the circuit **2080**. Once engaged, the circuit **2090** would dissipate the excess energy to a ground, ground, plane, capacitor, battery ground, or the like.

FIG. **54** discloses a circuit **2092** wherein directional circuits **2094-2100** are connected through a common bus conductor **2102** to provide DC power and signals from generator **2104** as described previously herein.

FIGS. **55** and **56** disclose a circuit **2104** to illustrate another aspect of the invention. Accordingly, an alternating electric field is provided to a first transmission conductor by a signal generator **2102** and a second transmission conductor is provided by an antenna **2108** (see FIG. **55**) or wire **2124** (see FIG. **56**) that is connected to a relatively less positive side **2114-2122** within the directional circuit **2110**. A difference in DC potential between a relatively more positive side **2112** within the directional circuit, and relatively less positive side **2114-2122** is provided. Another aspect of the invention is sensing proximity with impedance changes within the directional circuits described herein (as it could be with any embodiment disclosed herein) by approaching any of the directional circuits or transmission conductors (also any of which are described herein), for example approaching **2108** (shown in FIG. **55**) and/or **2124** (as shown in FIG. **56**) with a conductive substance such as a person, including the touch of a person (human touch), or metallic material thereby changing the circulation of current flow within the directional circuit by changes in impedance through the capacitance of the conductive substance.

FIG. **57** discloses a circuit **2126** to illustrate another aspect of the invention. Accordingly, an alternating electric field is provided to a transmission conductor **2132** by a signal generator **2128** that provides a first voltage level output equal to that provided by the signal generator **2128**. A lump inductance **2130** is provided in series of the transmission conductor **2132** between the signal generator **2128** and directional circuit **2134**. The lump inductance **2130** provides an increased voltage level from the relatively lower voltage on the transmission conductor **2132** at the point **2136** between the signal generator **2128** and lump inductance **2136** and a relatively higher voltage level on the transmission conductor **2132** at the point **2138** between the lump inductance **2130** and the directional circuit **2134** thereby providing an increase in current flow within the directional circuit **2134** or electromagnetic field energy

radiating from the circuit **2126**. The amount of current flow within the directional circuits described herein and electromagnetic field energy external of the directional circuits described herein is dependent on the frequency of an AC signal provided to the transmission conductor **2132** (or any of which are described herein). In preferred embodiments, the circuits disclosed in FIGS. **44-57** may be connected to ground through capacitance. This ground connection seems to provide increased circulation current, as it is noted that the LEDs get brighter for a given alternating electromagnetic source.

FIG. **58** discloses a circuit **2140** according to the invention having a standard AC signal generator **2142** and a directional circuit **2144** that includes first and second diodes **D1**, **D2**, the first diode **D1** has an anode and the second diode **D2** has a cathode, which are commonly connected to the transmission conductor **2146** from the generator **2142**. The cathode of diode **D1** is connected to the relatively more positive side **2148** of an organic light emitting diode (OLED) **2152** while the anode of diode **D2** is connected to the relatively less positive side **150** of the OLED **2152** to form the loop circuit **2144** among the diodes **D1**, **D2** and the OLED **2152**.

FIGS. **59**, and **61-62** disclose another embodiment of the invention having a directional organic light emitting diode ("OLED") circuit **2154** that includes a first diode D1 **2156**, a second diode D2 **2158**, and an OLED **2157**. The first diode D1 **2156** has an anode and the second diode D2 **2158** has a cathode, which are commonly connected to an input transmission conductor **2160**. The cathode of diode D1 **2156** is connected to the relatively more positive side **2162** anode of an OLED **2157** while the anode of diode D2 **2158** is connected to the relatively less positive side cathode **2164** of the OLED **2157** to form the loop circuit **2154** among the diodes D1, D2 and the OLED **2157**. The directional OLED circuit **2154** is a loop circuit which includes one or more circuit elements (e.g. diodes or OLEDs **2156, 2157** and **2158**) causing the loop circuit to be asymmetric to current flow. Circuit element **2157** is an OLED. The directional OLED circuit **2154** does not have a continuous conductive path to earth ground, or battery ground. The directional OLED circuit **2154** develops a DC potential in response to an alternating electric field imposed on input **2160**. The directional OLED circuit **2154** is self referencing between a relatively high potential output and a relatively lower potential output. The directional OLED circuit **2154** has a resistance, inductance and capacitance that is responsive to the voltage and frequency of the alternating electric field. The directional OLED circuit **2154** has transmission conductors **2166, 2168** connected to the directional OLED circuit **2154**.

FIG. **60** discloses another embodiment of the invention having a directional organic light emitting diode ("OLED") circuit **2170** that includes a first OLED **2172**, a second OLED **2174**, and a third OLED **2176**. The first OLED **2172** has an anode and the third OLED **2176** has a cathode, which are commonly connected to an input transmission conductor **2178** having AC signal source from a signal generator **2180**. The cathode of the first OLED **2172** is connected to the anode of the second OLED **2174** while the cathode of the second OLED **2174** is connected to the anode of the third OLED **2176** to form the loop circuit **2170** among the OLEDs **1, 2** and **3 (2172-2176)**. The directional OLED circuit **2170** can be designed with more than 3 OLEDs.

FIG. **61** discloses a circuit **2182** with the same embodiment of the invention shown in FIG. **59** (see FIG. **59**) encasing the directional OLED circuit **2154** within a package **2163**.

FIG. **62** discloses a circuit **2184** with the same embodiment of the invention shown in FIG. **59** (see FIG. **59**) with a second transmission conductor **2185** providing an input within the directional circuit **2184** at a point other than the input of the first transmission conductor input of **2160**. The transmission conductors **2160** and **2185** (or any transmission conductors described herein) can act as an antenna and cause the directional OLED circuit **2184** to react to the proximity of conductive substances near the transmission conductors **2160** and **2185**. In preferred embodiments, the circuits disclosed in FIGS. **59-66** may be connected to ground through capacitance at a point within the directional circuit such as transmission conductor **2185** (e.g. FIG. **62**). This ground connection seems to provide increased circulation current, as it is noted that the OLEDs get brighter for a given alternating electromagnetic source.

FIG. **63** discloses a matrix circuit **2186** comprised of twelve circuits **2154** (e.g. FIG. **61**). The circuits in the matrix **2186** are connected commonly to a transmission conductor **2188**.

FIG. **64** discloses a matrix circuit **2190** identical to matrix circuit **2186** but that the circuits **2191** employ only LEDs or optionally OLEDs.

FIG. **65** discloses a matrix circuit **2192** identical to matrix circuit **2186** but that the circuits **2193** in the matrix **2192** are connected commonly to one end of a lump inductance **2196** placed in series of the transmission conductor **2194** between the signal generator **2198** and the matrix circuit.

FIG. **66** discloses a matrix circuit **2200** identical to matrix circuit **2192** but that the circuits in the matrix **2200** are connected to individual lump inductances **2201-2206** which can be of equal or different values.

FIG. **67** shows a device **2482** comprising individual light emitting diode circuits **2484** on a flexible printed circuit board having a mirror like reflective material or coating **2488** designed into or on the flexible printed circuit board in an area at least near the light emitting diodes for providing more efficient light output from the circuit board areas surrounding the light emitting diodes by having the flexible printed circuit board reflect light rather than absorb it. Power connection points **2490** and **2492** are provided to the board.

FIG. **68** shows a device **2494** comprising a device **2496** identical to the device shown in FIG. **67** adhered to a device **2498** having a cylindrical shape for providing improved uniformity and increased angle of light output from device **2496**.

A circuit includes a first source for providing an alternating electric field, a directional circuit is connected to the first source for providing an alternating electric field by a transmission conductor there being no conductive DC path is provided back from the directional circuit to the first source for providing an alternating electric field. The directional circuit being a loop circuit which includes one or more circuit elements causing the loop circuit to be asymmetric to current flow; the directional circuit having no continuous conductive path to earth ground, or battery ground, the directional circuit thereby developing a DC potential in response to the alternating electric field which is self referencing between a relatively high potential output and a relatively lower potential output. One or more loads connected to the directional circuit, the one or more loads also not having a continuous conductive path to earth ground or a battery ground. The load is not provided with a continuous connection to earth ground, or battery ground. The load may be provided with a capacitive connection to earth ground, or battery ground. The DC current flow within the directional circuit is adjustable by tuning the directional circuit to

different frequencies of an alternating electric field thereby causing the directional circuit to reach a resonant state. The current flow increases within the directional circuit and the electromagnetic field is concentrated within the directional circuit when the directional circuit is tuned to a resonant frequency. The directional circuit being tuned out of its resonant frequency and providing a larger electromagnetic field surrounding the exterior of the directional circuit enables the directional circuit to be responsive to the proximity of objects having a capacitance that enter the electromagnetic field. The directional circuit is tuned towards resonance as conductive objects enter the electromagnetic field of the directional circuit.

The above-described embodiments of the present invention are intended to be examples only. Alterations, modifications and variations may be effected to the particular embodiments by those of ordinary skill in the art without departing from the scope of the invention, which is defined by the claims appended hereto.

What is claimed is:

1. An apparatus comprising:

a first device including a first circuit having a first transmission conductor and a first inductor, wherein said first circuit is configured to use at least the first inductor to transmit power from the first devicc wirelessly; and

a second device including

(a) at least one LED,

(b) a second circuit configured to detect contact with a conductive substance via capacitive sensing for controlling the at least one LED, and

(c) a third circuit having a second transmission conductor and a second inductor, wherein said second device is configured to use at least the second inductor to receive power wirelessly from said first device for powering the apparatus.

2. The apparatus of claim **1**, wherein said first device comprises at least one colored LED.

3. The apparatus of claim **1**, wherein said second device is adapted to receive power from a power supply connected to an AC mains.

4. The apparatus of claim **1**, wherein said first device is configured to transmit power and data.

5. The apparatus of claim **1**, wherein said second device comprises a three-way switch.

6. A method of operating an apparatus, the method comprising:

receiving power wirelessly in the apparatus;

transmitting or receiving data signals wirelessly;

detecting contact with a conductive substance via capacitive sensing; and

increasing a level of power to an LED circuit comprising at least one LED in the apparatus after detection of the contact.

7. An apparatus comprising:

an LED circuit including a plurality of LEDs;

a data receiver, wherein the data receiver is configured to receive data from an antenna;

a first circuit configured to detect contact with a conductive substance via capacitive sensing for at least controlling the LED circuit;

a second circuit having a transmission conductor and an inductor, wherein the second circuit is configured to use at least the inductor to receive power wirelessly for powering the apparatus; and

a lens doped with particles configured to transmit light, wherein the apparatus is portable.

8. The apparatus of claim **7**, wherein said apparatus is configured to provide power to said LED circuit after detection of a touch.

9. An apparatus comprising:

an LED circuit including at least one LED;

a data receiver, wherein the data receiver is configured to receive data from an antenna;

a capacitor coupled to the antenna, wherein the capacitor is configured to tune the antenna; and

a transmission conductor configured to wirelessly receive an alternating electromagnetic field that is used to provide power to charge the apparatus,

wherein the apparatus is portable.

10. An apparatus comprising:

an LED circuit comprising at least one LED;

a power supply, wherein said power supply is configured to provide power to the apparatus and is configured to receive power wirelessly from a power source;

a circuit configured to detect contact with a conductive substance for controlling at least the LED circuit; and

a data receiver, wherein said data receiver is configured to receive data from an antenna.

11. The apparatus of claim **10**, wherein said circuit is configured to detect contact with the conductive substance via capacitive sensing.

12. The apparatus of claim **10**, wherein said apparatus is configured to receive power from an AC mains power supply.

13. An apparatus comprising:

a flat planar substrate upon which is mounted a plurality of LEDs;

a data receiver, wherein the data receiver is configured to receive data from an antenna; and

a circuit configured to detect contact with a conductive substance for controlling the plurality of LEDs.

14. The apparatus of claim **13**, wherein power is provided to said plurality of LEDs after said circuit detects the contact with the conductive substance.

15. The apparatus of claim **13**, wherein said LEDs are organic LEDs.

16. An apparatus comprising:

an LED circuit comprising at least one LED;

a data receiver, wherein the data receiver is configured to receive data from a first antenna;

a second antenna configured to receive radio frequency noise, wherein said radio frequency noise is used to provide power to said apparatus; and

a circuit configured to detect contact with a user via capacitive sensing for at least controlling the LED circuit,

wherein said apparatus is portable.

17. An apparatus comprising:

an LED circuit comprising at least one LED;

a circuit configured to detect contact with a conductive substance for at least controlling the LED circuit; and

a data receiver, wherein said data receiver is configured to receive data from an antenna,

wherein said apparatus is portable.

18. An apparatus comprising:

a flat planar substrate upon which is mounted a plurality of LEDs;

a transmission conductor configured to provide data and power to said apparatus; and

a data receiver,

wherein the data receiver is configured to receive the data from the transmission conductor or an antenna and the power from the transmission conductor.

19. The apparatus of claim **18**, wherein the LEDs are Organic LEDs.

20. The apparatus of claim **18**, wherein said apparatus further comprises a MODEM.

21. A system comprising:

a first device, wherein the first device includes (a) at least one LED, (b) at least one antenna, (c) at least one data communications circuit, and (d) at least one battery, and wherein the first device is configured to detect contact with a conductive substance via capacitive sensing for controlling at least the at least one LED; and

a second device, wherein the second device is configured to transmit power and signals wirelessly to the first device.

22. A system comprising:

a transmit device, wherein the transmit device is configured to transmit power and signals; and

a data communications device, wherein the data communications device includes (a) at least one LED, (b) at least one antenna, and (c) at least one data communications circuit,

wherein the transmit device is configured to transmit power and signals wirelessly to the data communications device using resonance and inductance.

23. The apparatus of claim **1**, wherein the conductive substance includes a metallic material.

24. The method of claim **6**, wherein the conductive substance includes a metallic material.

25. The apparatus of claim **7**, wherein the conductive substance includes a metallic material.

* * * * *

U.S. DEPARTMENT OF COMMERCE
United States Patent and Trademark Office

July 3, 2023
(Date)

THIS IS TO CERTIFY that the attached document is a list of the papers that comprise the record before the Patent Trial and Appeal Board (PTAB) for the *Inter Partes Review* proceeding identified below.

SAMSUNG ELECTRONICS CO. LTD.,
Petitioner,

v.

LYNK LABS, INC.,
Patent Owner.

Case: IPR2021-01347
Patent No. 10,966,298 B2

By authority of the

DIRECTOR OF THE UNITED STATES
PATENT AND TRADEMARK OFFICE

Certifying Officer

Prosecution History ~ IPR2021-01347

Date	Document
9/7/2021	Petition for Inter Partes Review
9/7/2021	Petitioner's Power of Attorney
9/27/2021	Notice of Filing Date Accorded to Petition and Time for Filing Patent Owner's Preliminary Response
9/28/2021	Patent Owner's Mandatory Notices
3/15/2022	Petitioner's Updated Mandatory Notices
3/15/2022	Scheduling Order
3/15/2022	Decision - Institution of Inter Partes Review
4/1/2022	Patent Owner's Updated Mandatory Notices
4/14/2022	Patent Owner's Power of Attorney
4/20/2022	Patent Owner's Updated Mandatory Notices
4/26/2022	Parties' Stipulation to Modify Trial Due Dates 1, 2 and 3
5/9/2022	Notice of Deposition - Baker
5/11/2022	Petitioner's Updated Mandatory Notices
6/21/2022	Patent Owner's Response
8/18/2022	Notice of Deposition - Credelle
9/13/2022	Petitioner's Current List of Exhibits
9/13/2022	Petitioner's Reply to Patent Owner's Response
10/6/2022	Panel Change Order - Conduct of the Proceedings
10/25/2022	Patent Owner's Sur-Reply
11/1/2022	Petitioner's Request for Oral Argument
11/1/2022	Patent Owner's Request for Oral Argument
11/3/2022	Order - Setting Oral Argument
11/7/2022	Patent Owner's Updated Mandatory Notices
12/12/2022	Petitioner's Current List of Exhibits
12/12/2022	Patent Owner's Updated List of Exhibits
1/24/2023	Oral Hearing Transcript
3/13/2023	Final Written Decision

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.
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Patent Owner

Patent No. 10,966,298

**PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 10,966,298**

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Ex. 1002	Declaration of R. Jacob Baker, Ph.D., P.E.
Ex. 1003	Curriculum Vitae of R. Jacob Baker, Ph.D., P.E.
Ex. 1004	Prosecution History of U.S. Patent No. 10,966,298
Ex. 1005	Australian Patent Application Publication No. AU2003100206 ("*Birrell*")
Ex. 1006	GB Patent Application Publication No. 2202414 ("*Logan*")
Ex. 1007	U.S. Patent No. 5,028,859 ("*Johnson*")
Ex. 1008	U.S. Patent Application Publication No. 2002/0060530 ("*Sembhi*")
Ex. 1009	U.S. Patent Application Publication No. 2002/0030194 ("*Camras*")
Ex. 1010	U.S. Patent Application Publication No. 2002/0175870 ("*Gleener*")
Ex. 1011	U.S. Patent No. 6,882,128 ("*Rahmel*")
Ex. 1012	U.S. Patent No. 4,654,880 to Sontag ("*Sontag*")
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Ex. 1030	U.S. Patent Application Publication No. 2003/0137258 ("*Piepgras*")
Ex. 1031	U.S. Patent No. RE 33,285 ("*Kunen*")
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Ex. 1041	U.S. Patent No. 10,750,583
Ex. 1042	U.S. Patent No. 10,575,376
Ex. 1043	U.S. Patent No. 10,492,252
Ex. 1044	U.S. Patent No. 10,492,251
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Ex. 1050	U.S. Patent No. 8,179,055
Ex. 1051	U.S. Patent No. 8,148,905
Ex. 1052	U.S. Patent No. 7,489,086
Ex. 1053	WO2010138211 (Application No. PCT/US2010/001597)
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Ex. 1055	U.S. Provisional Application No. 61/333,963
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Exs. 1063-1079	RESERVED
Ex. 1080	U.S. Patent No. 6,879,319 ("*Cok*")
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Ex. 1089	U.S. Patent Application Publication No. 2004/0207484 (“*Forrester*”)
Ex. 1090	RESERVED
Ex. 1091	U.S. Patent Application Publication No. 2003/0122502 (“*Clauberg*”)
Ex. 1092	U.S. Patent Application Publication No. 2005/0128751 (“*Roberge*”)
Ex. 1093	U.S. Patent Application Publication No. 2002/0195968 (“*Sanford*”)
Ex. 1094	WO 03/009535 A1 (Application No. PCT/JP020/07198) (Japanese original and English translation, including translator’s certification) (“*Oba*”)[1]
Ex. 1095	Universal Serial Bus Specification Revision 2.0, April 27, 2000
Ex. 1096	U.S. Patent No. 5,293,494 (“*Saito*”)
Ex. 1097	U.S. Patent No. 6,814,642 (“*Siwinski*”)
Ex. 1098	U.S. Patent Application Publication No. 2003/0076306 (“*Zadesky*”)
Ex. 1099	U.S. Patent Application Publication No. 2003/0231168 (“*Bell*”)
Ex. 1100	U.S. Patent No. 6,907,089 (“*Jensen*”)
Ex. 1101	U.S. Patent No. 5,532,641 (“*Balasubramanian*”)
Ex. 1102	U.S. Patent Application Publication No. 2003/0146897 (“*Hunter*”)
Ex. 1103	U.S. Patent No. 6,439,731 (“*Johnson-731*”)

[1] References to Ex. 1094 are to English translation document page:line numbers.

Ex. 1104	U.S. Patent No. 7,348,957 ("*Cui*")
Ex. 1105	U.S. Patent No. 4,573,766 ("*Bournay*")
Ex. 1106	U.S. Patent Application Publication No. 2002/0191029 ("*Gillespie*")
Ex. 1107	Case docket in *Samsung Elecs. Co., Ltd., v. Lynk Labs, Inc.* No. 1:21-cv-2665 (N.D. Ill.) (accessed Sept. 2, 2021)
Ex. 1108	Estimated Patent Case Schedule for Northern District of Illinois (available at https://www.ilnd.uscourts.gov/_assets/_documents/_forms/_judges/Pacold/Estimated%20Patent%20Schedule.pdf)
Ex. 1109	Lynk Labs, Inc.'s Preliminary Infringement Contentions in *Samsung Elecs. Co., Ltd. v. Lynk Labs, Inc.*, No. 1:21-cv-2665 (N.D. Ill.) (served July 21, 2021)
Ex. 1110	Lynk Labs, Inc.'s Exemplary Infringement Charts for U.S. Patent No. 10,966,298 (Apps. A-6, B-6, D-6, E-4, G-5, H-4, I-4) accompanying Lynk Labs, Inc.'s Preliminary Infringement Contentions in *Samsung Elecs. Co., Ltd. v. Lynk Labs, Inc.*, No. 1:21-cv-2665 (N.D. Ill.) (served July 21, 2021)
Ex. 1111	Lynk Labs, Inc.'s First Amended Complaint (Dkt. #11) in *Lynk Labs, Inc. v. Samsung Electronics, Co., Ltd.*, 6:21-cv-00526-ADA (June 9, 2021)
Ex. 1112	U.S. Patent No. 8,055,310 ("*Beart*")
Ex. 1113	Lynk Labs, Inc.'s Amended Preliminary Infringement Contentions in *Samsung Elecs. Co., Ltd. v. Lynk Labs, Inc.*, No. 1:21-cv-2665 (N.D. Ill.) (served Aug. 31, 2021)
Ex. 1114	Lynk Labs, Inc.'s Exemplary Infringement Charts for U.S. Patent No. 10,966,298 (Apps. A-6, B-6, D-6, E-4, G-5, H-4, I-4) accompanying Lynk Labs, Inc.'s Amended Preliminary Infringement Contentions in *Samsung Elecs. Co., Ltd. v. Lynk Labs, Inc.*, No. 1:21-cv-2665 (N.D. Ill.) (served Aug. 31, 2021)

Ex. 1115	Notification of Docket Entry (Dkt. #50) in *Samsung Elecs. Co., Ltd.*, *v. Lynk Labs, Inc.*, No. 1:21-cv-2665 (N.D. Ill. July 27, 2021)
Ex. 1116	Order (Dkt. #57) in *Samsung Elecs. Co., Ltd.*, *v. Lynk Labs, Inc.*, No. 1:21-cv-2665 (N.D. Ill. Aug. 19, 2021)

I. INTRODUCTION

Samsung Electronics Co., Ltd. ("Petitioner" or "Samsung") requests *inter partes* review of claims 1-25 ("challenged claims") of U.S. Patent No. 10,966,298 ("the '298 patent") (Ex. 1001) assigned to Lynk Labs, Inc. ("PO"). For the reasons below, the challenged claims should be found unpatentable and canceled.

II. MANDATORY NOTICES

Real Parties-in-Interest: Petitioner identifies the following as the real parties-in-interest: Samsung Electronics Co., Ltd., and Samsung Electronics America, Inc.

Related Matter: The '298 patent is at issue in the following matter(s):

- *Samsung Electronics Co., Ltd. v. Lynk Labs, Inc.*, No. 1-21-cv-02665 (N.D. Ill.) (seeking declaratory judgment of non-infringement as to the '674 patent and also U.S Patent Nos. 10,492,252, 10,499,466, 10,966,298, 11,019,697, 10,492,251, 10,750,583, 10,687,400, and 10,517,149) ("Illinois Litigation").

The '298 patent claims priority to two provisional applications (U.S. Provisional Application Nos. 60/574,653 filed February 25, 2004 and 60/559,867 filed April 6, 2004) to which U.S. Patent No. 8,531,118, which was at issue in IPR2016-01133, also claims priority.

<u>Counsel and Service Information</u>: Lead counsel: Naveen Modi (Reg. No. 46,224), and Backup counsel are (1) Joseph E. Palys (Reg. No. 46,508), (2) Arvind Jairam (Reg. No. 62,759), (3) Howard Herr (*pro hac vice* admission to be requested). Service information is Paul Hastings LLP, 2050 M St., Washington, D.C., 20036, Tel.: 202.551.1700, Fax: 202.551.1705, email: PH-Samsung-LynkLabs-IPR@paulhastings.com. Petitioner consents to electronic service.

III. PAYMENT OF FEES

The PTO is authorized to charge any fees due during this proceeding to Deposit Account No. 50-2613.

IV. GROUNDS FOR STANDING

Petitioner certifies that the '298 patent is available for review and Petitioner is not barred or estopped from requesting review on the grounds identified herein.

V. PRECISE RELIEF REQUESTED AND GROUNDS

Claims 1-25 should be canceled as unpatentable based on the following grounds:

<u>Ground 1</u>: Claims 1, 3, 4, 10-15, 17-21, and 23 are unpatentable under pre-AIA 35 U.S.C. § 103(a) as being obvious over *Birrell* and *Logan*;

<u>Ground 2</u>: Claim 2 is unpatentable under § 103(a) as being obvious over *Birrell*, *Logan*, and *Johnson*;

<u>Ground 3</u>: Claims 3, 10-12, and 21 are unpatentable under § 103(a) as being obvious over *Birrell*, *Logan*, and *Zhang*;

<u>Ground 4</u>: Claim 5 is unpatentable under pre-AIA 35 U.S.C. § 103(a) as being obvious over *Birrell*, *Logan*, and *Sembhi*;

<u>Ground 5</u>: Claims 6, 18, and 24 are unpatentable under pre-AIA 35 U.S.C. § 102 as being anticipated by *Birrell*;

<u>Ground 6</u>: Claims 7, 8, and 25 are unpatentable under pre-AIA 35 U.S.C. § 103(a) as being obvious over *Birrell*, *Logan*, and *Camras*;

<u>Ground 7</u>: Claim 9 is unpatentable under pre-AIA 35 U.S.C. § 103(a) as being obvious over *Birrell*, *Logan*, and *Gleener*;

<u>Ground 8</u>: Claim 16 is unpatentable under § 103(a) as being obvious over *Birrell*, *Logan*, and *Rahmel*; and

<u>Ground 9</u>: Claim 22 is unpatentable under § 103(a) as being obvious over *Birrell*, *Logan*, and *Sontag*.

The '298 patent issued from an application filed May 4, 2020, and claims priority via a chain of applications dating back to February 25, 2004. For purposes of this proceeding, and without conceding the '298 patent is entitled to such a date, Petitioner assumes the critical date for the '298 patent is February 25, 2004.

Birrell published July 17, 2003, *Logan* published September 21, 1988, *Johnson* published July 2, 1991, *Sembhi* published May 23, 2002, *Camras* published

March 14, 2002, *Gleener* published November 28, 2002, *Sontag* published March 31, 1987, *Zhang* published February 21, 2002, and thus each qualifies as prior art at least under pre-AIA 35 U.S.C. § 102(b). *Rahmel* filed September 27, 2000 and issued April 19, 2005, and thus it qualifies as prior art at least under pre-AIA 35 U.S.C. § 102(e). None of these references were considered during prosecution. (*See generally* Ex. 1004.)

VI. LEVEL OF ORDINARY SKILL

A person of ordinary skill in the art as of the claimed priority date of the '298 patent ("POSITA") would have had at least a bachelor's degree in electrical engineering, computer engineering, computer science, physics, or the equivalent, and two or more years of experience with LED devices and/or related circuit design, or a related field. (Ex. 1002, ¶¶20-21.)[2] More education can supplement practical experience and vice versa. (*Id.*)

[2] Petitioner submits the declaration of R. Jacob Baker, Ph.D., P.E. (Ex. 1002), an expert in the field of the '298 patent. (Ex. 1002, ¶¶1-14, 20-55 (citing, *inter alia*, Exs. 1027-1031, 1080-1087, 1089, 1091, 1093-1106); Ex. 1003.)

VII. OVERVIEW OF THE '298 PATENT

A. The '298 patent

While the '298 patent purports to identify an invention directed to an LED device/system having various features (*e.g.,* Ex. 1001, 4:30-11:3, 13:36-61), the claims are broadly directed to generic apparatuses and methods that include compilations of familiar one-off components/features that provide no novel functionality (e.g., LEDs, data receiver, transmission conductor, inductor, three-way switch, AC mains, and capacitive touch detection).[3] As explained below, the collection of such generically claimed features were known and obvious. *See In re Gorman*, 933 F.2d 982, 986 (Fed. Cir. 1991) ("The criterion ... is not the number of references, but what they would have meant to a person of ordinary skill in the field of the invention."). (*Infra* Section IX; Ex. 1002, ¶¶14-19, 22-57; Exs. 1040-1062.)

VIII. CLAIM CONSTRUCTION

The Board only construes the claims when necessary to resolve the underlying controversy. *Toyota Motor Corp. v. Cellport Systems, Inc.*, IPR2015-00633, Paper No. 11 at 16 (Aug. 14, 2015) (citing *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200

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[3] PO's infringement contentions in the Illinois Litigation fail likewise fail to provide much detail regarding the claimed features. (*E.g.*, Ex. 1110, 1-38; Ex. 1109; Ex. 1113; Ex. 1114, 1-34.)

F.3d 795, 803 (Fed. Cir. 1999)). For purposes of this proceeding, Petitioner believes that no special constructions are necessary to assess whether the challenged claims are unpatentable over the asserted prior art.[4] (Ex. 1002, ¶58.)

IX. DETAILED EXPLANATION OF GROUNDS[5]

As discussed below, claims 1-25 are unpatentable in view of the prior art. (Ex. 1002, ¶¶14-208.)

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[4] Petitioner reserves all rights to raise claim construction and other arguments, including challenges under 35 U.S.C. §§ 101 or 112, in district court as relevant to those proceedings. *See, e.g.*, *Target Corp. v. Proxicom Wireless, LLC*, IPR2020-00904, Paper 11 at 11–13 (Nov. 10, 2020). A comparison of the claims to any accused products in litigation may raise controversies that are not presented here given the similarities between the references and the patent.

[5] Section IX references exhibits other than the identified prior art for each ground. Such exhibits reflect the state of the art known to a POSITA at the time of the alleged invention consistent with the testimony of Dr. Baker.

A. Ground 1: Claims 1, 3, 4, 10-15, 17-21, and 23 Are Obvious Over *Birrell* and *Logan*

1. Claim 1

a) An apparatus comprising:

To the extent limiting, *Birrell* discloses this limitation.[6] (Ex. 1002, ¶¶67-70.) For example, *Birrell* discloses "a system for connecting an electrical device to a power source," where "the device may be coupled to the power source without requiring any direct connection," e.g., a wireless lighting system ("apparatus"). (Ex. 1005, 2:36-3:16, 3:17-27; Ex. 1002, ¶¶67-68; *see also* Ex. 1005, Abstract, 2:3-5, 16:37-18:13, FIGS. 1-3 and 8.)

Birrell's system includes a lighting tile 50 having LEDs 59. (Ex. 1005, 14:26-15:33, FIG. 1 (annotated below).) Metalized strips 55 and 56 "act as electrical coupling elements for the tile 50 to enable it to be capacitively coupled to a power source," facilitating wireless power transfer. (*Id.*; *see also id.*, 16:37-18:13, 17:21-28; Ex. 1002, ¶69.)

[6] PO asserts a mobile phone "when used with a wireless charger" collectively "is an apparatus." (Ex. 1110, 2, 40; Ex. 1114, 2, 36.)

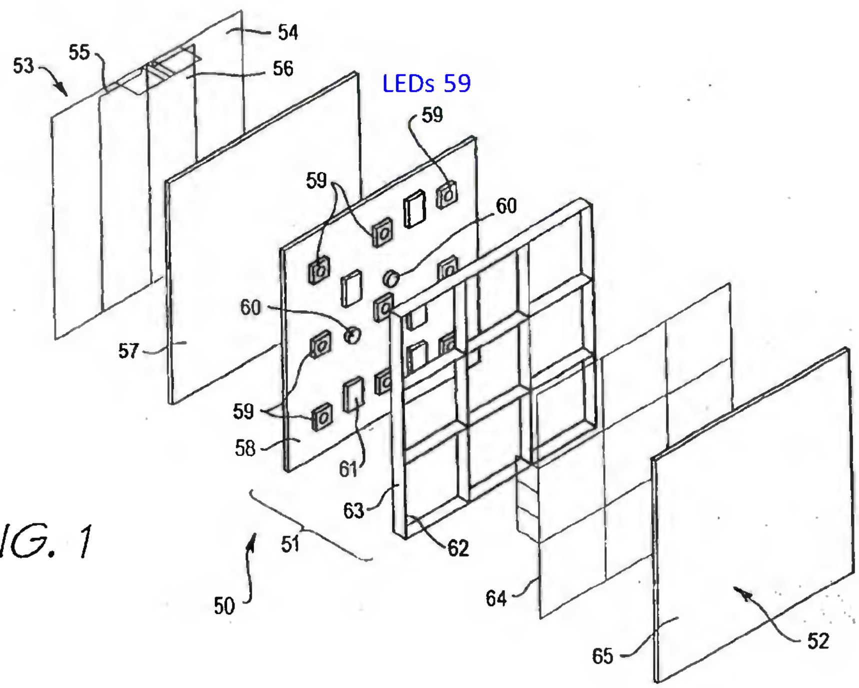


FIG. 1

Figure 8 shows a circuit diagram of the "apparatus" that includes "LEDs…capacitively coupled to an AC power supply" via capacitors C_A and C_B. (Ex. 1005, FIG. 8 (below), 20:26-31; *see also id.*, 14:8-13, 21:34, 23:2-11; Ex. 1002, ¶70; *infra* Sections IX.A.1(b)-(c).)

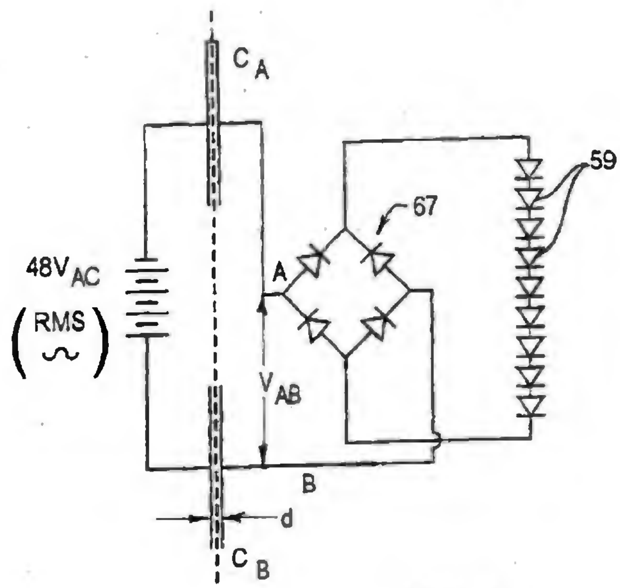


FIG 8

b) a first device including a first circuit having a first transmission conductor and a first inductor, wherein said first circuit is configured to use at least the first inductor to transmit power from the first device wirelessly; and

Birrell in view of *Logan* discloses and/or suggests this limitation. (Ex. 1002, ¶¶71-80.) *Birrell*'s lighting system includes a first device that includes a circuit comprising a conductive wire that connects to an AC power supply and to capacitors, which transmits wireless power to lighting tile 50's LEDs 59 through circuit 67. (Ex. 1005, FIG. 8 (below), 3:17-27, 20:26-31; 21:34, 22:29-30, 23:2-11; Ex. 1002, ¶71.)

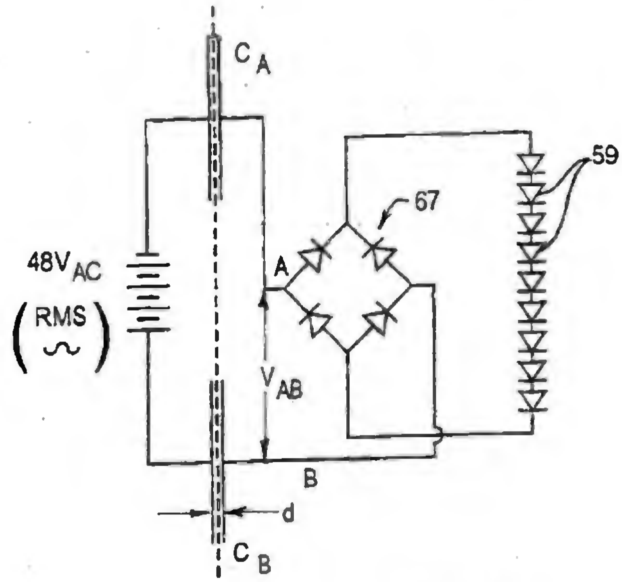


FIG 8

As shown in Figures 3, 8, a conductor connects the AC power supply to capacitor C_A and another conductor connects to capacitor C_B in order to transmit the AC power that is wirelessly sent to tile 50 having LEDs 59. (Ex. 1002, ¶71; Ex. 1005, FIGS. 3 (below), 8, 17:25-28.)

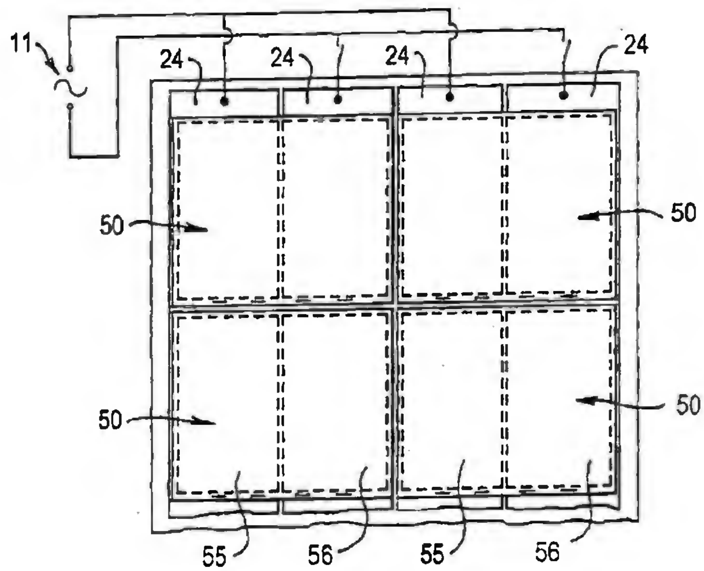


FIG 3

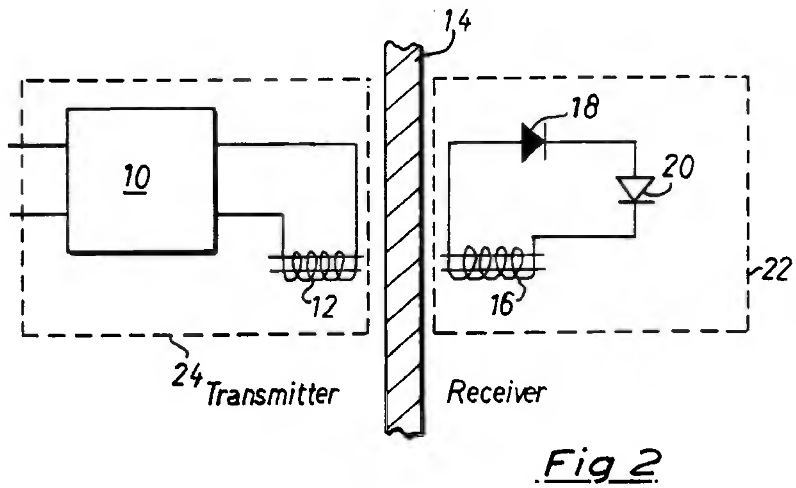
Tile 50's "metallised strips" 55 and 56 of are capacitively coupled to "metallised strips" 24 that are connected to the power supply via the conductors on the other circuit (left side of FIG. 8's dashed line), where strips 55/56 and strips 24 are separated by an insulator. (Ex. 1005, Abstract, FIGS. 2-3, 17:4-17:36 ("metallised strips act as electrical coupling elements" with "[i]nsulating layers"), 17:37-18:12; Ex. 1002, ¶72.) Thus, an insulator (dotted line in Figure 8) separates strips 55/56 of tile 50 from strips 24, which are part of the other circuit connected to the 48V AC power supply, where each of capacitors C_A and C_B are formed by a combination of strips 55/56, the insulator, and strips 24. (Ex. 1002, ¶72; Ex. 1005, 18:6-12; 20:26-31, 21:34, 22:29-30, 23:2-11.) The conductors connecting the power

supply to capacitors C_A and C_B (and strips forming a part of the capacitors) constitutes a circuit because electric current flows through these components consistent with the operations of *Birrell*'s system. (Ex. 1002, ¶72.) Accordingly, *Birrell* discloses a "first device including a [first] circuit" having "a first transmission conductor" and that "the [first] circuit" is configured to wirelessly transmit power from the [first] device. (Ex. 1002, ¶72.)

While *Birrell* does not describe a first inductor used to wirelessly transmit power from the above described first device, a POSITA would have found it obvious to modify *Birrell* in view of *Logan* to implement such features. (Ex. 1002, ¶73.) Like *Birrell*, *Logan* discloses providing wireless power to an LED, including "across a panel/bulkhead" or a "wall." (Ex. 1006, Abstract, 1:3-2:6, 3:19-5:4, FIGS. 1-2.) Thus, a POSITA would have had reason to consider *Logan* when contemplating/implementing the system of *Birrell*. (Ex. 1002, ¶73.)

Logan's wireless power transfer is based on inductive coupling. (Ex. 1006, Abstract, 2:18-26, 7:21-26.) *Logan* discloses transmitting and receiving wireless power using coil 12 ("first inductor") and coil 16, where an oscillator 10 energizes coil 12 to create an "alternating electromagnetic flux," which induces an electromotive force in coil 16 for powering an LED 20. (*Id.*, Abstract, 3:19-5:4; FIGS. 1-2.) Thus, *Logan* discloses a device including an "inductor" to transmit

power from the device wirelessly to another device through, e.g., a partition/insulator, which is similar to *Birrell*'s arrangements. (Ex. 1002, ¶74.)



(Ex. 1006, FIG. 2.)

Based on *Birrell* and *Logan*, a POSITA would have been motivated to modify *Birrell*'s system to utilize inductive coupling to provide wireless power. (Ex. 1002, ¶75.) *Logan* describes the benefits of using inductive coupling to transmit wireless power in an LED lighting system. (Ex. 1006, 6:3-11 (given the "concentrated and localised nature" of the inductively-generated field, LED lightings "can be densely packed without interference problems"), 1:6-24 (interference issues with transmissions made in "closely adjacent positions"), 3:19-23.) Thus, a POSITA would have been motivated to implement *Logan*'s teachings/suggestions when

contemplating *Birrell*, especially when *Birrell* discloses closely packing multiple light tiles. (Ex. 1005, FIG. 3, 13:37-14:2, 23:30-24:2; Ex. 1002, ¶75.)

Additionally, a POSITA would have appreciated that using inductive coupling to provide wireless power in *Birrell* would allow for voltage magnitude adjustments by adjusting the windings of the coils, thus providing flexibility when implementing wirelessly powering devices of different voltage requirements. (Ex. 1002, ¶76.) Indeed, a POSITA would have known that a transmitting coil with more windings than the receiving coil reduces the magnitude of the transmitted voltage and vice versa. (*Id.*; Ex. 1013, 161-162.) Furthermore, *Logan* explains that its system "can operate with a wide variety of panel/bulkhead materials" (Ex. 1006, 4:1-5) and a POSITA would have appreciated that an inductively-coupled system/apparatus has improved transfer characteristics when properly configured (*see e.g.,* Ex. 1012, 2:12-19, 2:31-43, 4:50-5:48, FIGS. 1, 4-5; *infra* Section IX.I.1(d)). Thus, a POSITA would have appreciated that providing similar features in *Birrell*'s apparatus would have improved the flexibility in its design/implementation to accommodate different applications. (Ex. 1002, ¶76.)

Moreover, there were only a handful of known techniques for transmitting power wirelessly, including inductive coupling, capacitive coupling, magnetic resonance coupling, microwave, and laser. (Ex. 1002, ¶77.) Thus, using inductive coupling (e.g., as in *Logan*) with *Birrell* would have been obvious because it would

have been one of a "finite number of identified, predictable solutions." *Perfect Web Techs., Inc. v. InfoUSA, Inc.*, 587 F.3d 1324, 1331 (Fed. Cir. 2009).

A POSITA would have had the capability and a reasonable expectation of success in implementing inductive coupling in a system like *Birrell*, given the skills/knowledge of such a person at the time and the disclosures of *Logan* and *Birrell* (describing known ways for wirelessly powering LED devices). (Ex. 1002, ¶78; *see also* Ex. 1013, 161-162, 165-166, FIG. 5-4(c).) Indeed, implementing the above modification would have involved applying known technologies (e.g., wireless power (*Logan* and *Birrell*) with inductive coupling (*Logan*)) according to known methods (e.g., inductors to transmit/receive wireless power) to yield the predictable result of providing wireless power to LED lighting device(s) with reduced interference and with the flexibility to adjust the transmitted voltage for particular applications.[7] (Ex. 1002, ¶78.) *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 416 (2007).

[7] PO relies on use of "a wireless charger" for this limitation in the Illinois Litigation (Ex. 1110, 2, 40, 75; Ex. 1114, 2, 36, 69) and that "wireless charging **necessarily requires**…a transmission conductor and an **inductor**" (Ex. 1110, 13-14; Ex. 1114, 12).

For example, in one non-limiting way (others would have been contemplated), the modification would have involved implementations of known configurations, such as an example from a 1998 textbook, (Ex. 1002, ¶79; Ex. 1013, FIG. 5-4(c)), where the capacitive coupling features (formed by capacitors C_A and C_B as shown in Figure 8 of *Birrell*) were modified with inductive coupling features (formed by inductors (and related circuitry) similar to Figure 2 of *Logan*).[8] (Ex. 1002, ¶79.) The modification would have predictably resulted in use of an inductor to wirelessly transmit power (provided by *Birrell*'s AC power supply) to another inductor in lighting tile 50 to eventually power the LEDs 59 (generally exemplified below). (Ex. 1002, ¶79.)

[8] A POSITA would have further considered necessary design adjustments, e.g., operating voltage, frequency, power,…etc., to the circuitry to ensure the modification properly provided power consistent with *Birrell*'s operations. (Ex. 1002, ¶79.)

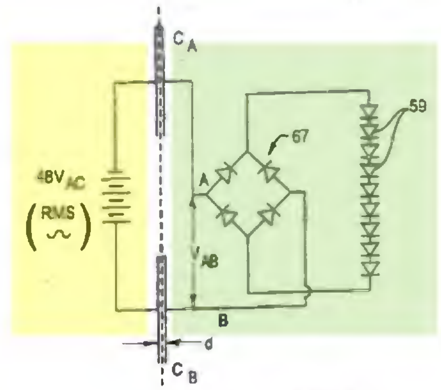


FIG 8

Birrell

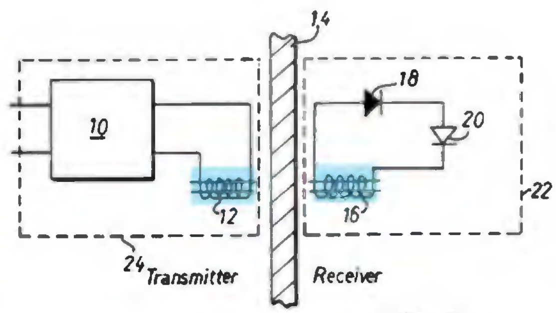
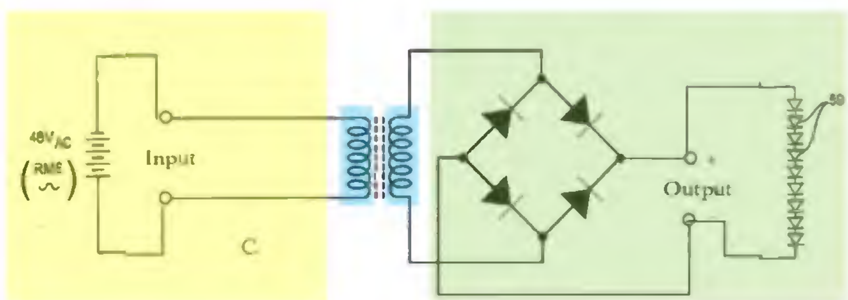


Fig 2

Logan



Demonstrative A

(Ex. 1002, ¶79.)[9]

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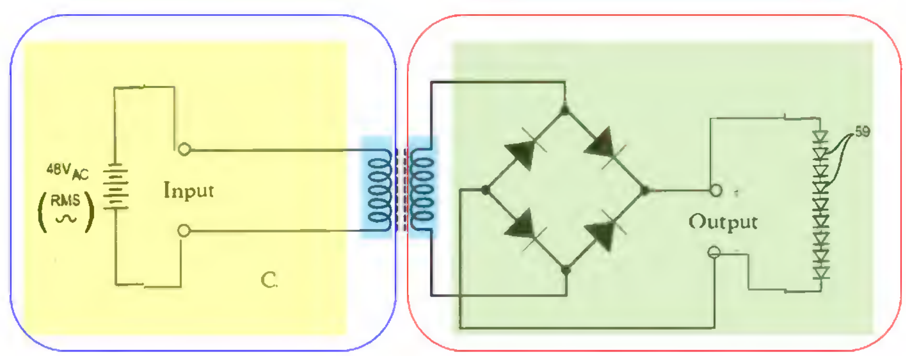
[9] The exemplary modified arrangement (the demonstratives here and below) is/are a high-level exemplary and non-limiting illustration(s), and does/do not necessarily

Thus, the *Birrell-Logan* combination discloses the claimed "first device" (e.g., exemplified below in blue box of Demonstrative F, including a "first circuit" comprising the conductor extending from the power supply ("first transmission conductor") and a "first inductor" (transmitting coil) used to transmit power from the "first device" wirelessly to the modified tile 50. (*Id.*, ¶80.)



Demonstrative F

depict(s) an exact schematic(s) of the details included and the only arrangement(s) resulting from the modification. Other designs/configurations including components and paths not shown may have been contemplated by a POSITA when designing/implementing such a modified apparatus. (Ex. 1002, ¶¶79-80.)

c) a second device including

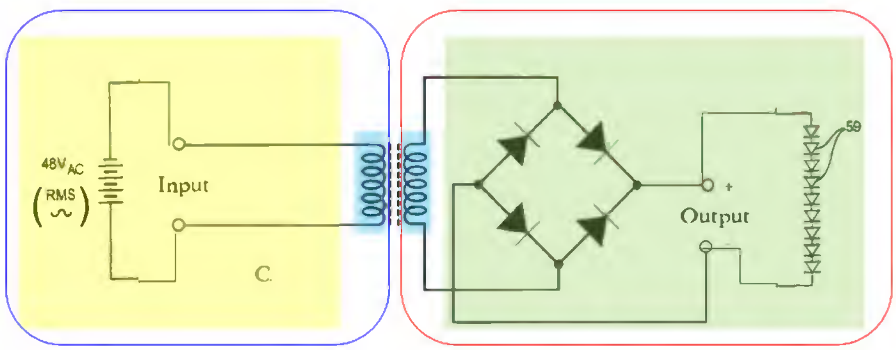
(1) (a) at least one LED,

(2) (b) a second circuit configured to detect contact with a conductive substance via capacitive sensing for controlling the at least one LED, and

The above *Birrell-Logan* combination discloses/suggests the claimed "second device." (Ex. 1002, ¶¶81-84.) *Birrell* discloses that lighting tile 50 includes "at least one LED" 59. (Ex. 1005, 14:26-15:33, FIG. 8; Ex. 1002, ¶81.) Tile 50 also includes a capacitive touch sensor that detects human touch. (Ex. 1002, ¶82; Ex. 1005, 16:18-26 (touch sensor "acts as a high impedance capacitive pick up for human touch sensing."); 15:21-33 (touch sensors 60 disposed on "circuit board 58" of tile 50.) The disclosed touch sensor necessarily includes a "[second] circuit" as claimed because without circuitry (e.g., conductive paths and components known to part of such known touch sensors), it would not operate as a touch sensor as described in *Birrell* (e.g., the touch sensor "enable[s] the lighting tile 50 to be controlled" and requires power). (Ex. 1002, ¶82; Ex. 1005, 16:18-26.)

A POSITA would have understood that a person making contact includes a "conductive substance." (Ex. 1002, ¶83; Ex. 1001, 20:30-36 ("a conductive substance such as a person…").) *Birrell*'s touch sensor also includes a metallised polymer film 64 that "enable[s] the lighting tile 50 to be controlled," which a POSITA would have understood included the LEDs. (Ex. 1005, 16:18-26, 8:4-7

(tile 50 includes electronic manually controlled touch switches or light level controls); Ex. 1002, ¶¶83-84.) Thus, *Birrell*'s "second device" (e.g., red box below) includes "a second circuit" configured to detect contact with a human (conductive substance) or using a conductive substance ("metallised polymer film 64" (also a "conductive substance") for controlling the LED(s) in lighting tile 50. (Ex. 1005, 16:18-26; Ex. 1002, ¶¶83-84.)

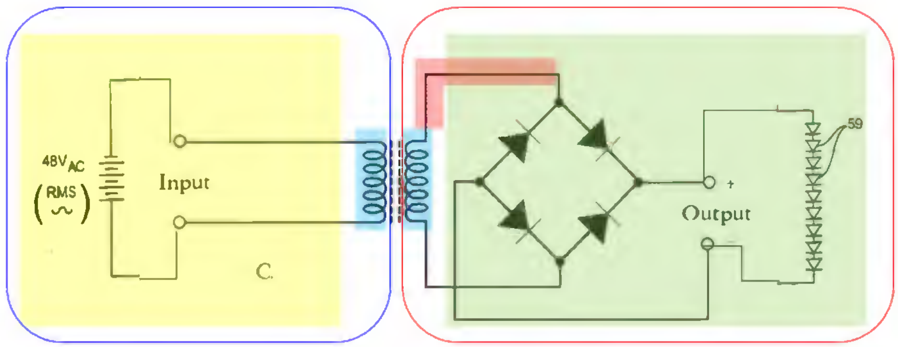


Demonstrative F

(3) (c) a third circuit having a second transmission conductor and a second inductor, wherein said second device is configured to use at least the second inductor to receive power wirelessly from said first device for powering the apparatus.

The *Birrell-Logan* combination discussed above discloses and/or suggests this limitation. (Ex. 1002, ¶85; Sections IX.A.1(b), IX.A.1(c)(2).) As explained, the modified tile 50 ("second device") of the *Birrell-Logan* combination would have been inductively coupled to the "first device" via a receiving coil ("second

inductor") to wirelessly receive power from the "first device" (limitation 1(b)). (Section IX.A.1(b).) Thus, for similar reasons, the modification would have resulted in tile 50 having a "third circuit" including a conductor ("second transmission conductor") extending from the receiving coil ("second inductor") that receives power wirelessly from the "first device" used for powering LEDs 59. (Ex. 1002, ¶85; Ex. 1005, 20:26-31 ("LEDs [are]…coupled to an AC power supply" and that the power supply "illuminate[s] the LEDs"); *id.*, 8:31-9:10 (system provides "data and power through the electrical coupling"), 22:29-30.) Thus, in the *Birrell-Logan* combination, the transmitting coil ("first inductor" (left blue coil below)) in the "first device" (blue box) would wirelessly transmit power to the receiving coil ("second inductor" (right blue coil) of the modified tile 50 ("second device" (red box)) for powering LEDs 59 via an electrical connection ("second transmission conductor" (e.g., red path, which may also extend to LEDs 59)). (Section IX.A.1(b); Ex. 1005, FIG. 8; Ex. 1002, ¶85.)



Demonstrative B

2. Claim 3

a) The apparatus of claim 1, wherein said second device is adapted to receive power from a power supply connected to an AC mains.

The *Birrell-Logan* combination discloses and/or suggests this limitation.[10] (Ex. 1002, ¶¶86-87.) As discussed, *Birrell* discloses a "second device" (modified tile 50) that wirelessly receives power from a 48V AC power supply. (Ex. 1005, 8:31-9:10, 20:26-31, 22:29-30; Section IX.A.1(b).)[11] While *Birrell* does not

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[10] PO asserts wired charging to an AC mains or a wireless charger connected to AC mains meets this limitation. (Ex. 1110, 7, 44-45; Ex. 1114, 6, 40.)

[11] PO asserts that "DC voltage" or "rectified AC voltage" may be provided to LEDs. (*Compare* Ex. 1111, ¶46, *with id.*, ¶58.)

expressly disclose that the power supply is "connected to an AC mains," it would have been obvious to implement such features in the *Birrell-Logan* modified apparatus. (Ex. 1002, ¶86.)

A POSITA would have understood that 110/120V AC power from the electrical grid is a commonly used and convenient way of providing power to lighting fixtures and other electronics. (Ex. 1002, ¶87; Ex. 1013, 157 (120V AC used to power lighting fixtures); Ex. 1024, 1:9-28, 1:35-48, FIG. 1; Ex. 1025, 1:10-25, FIG. 1 (AC-DC converter); Ex. 1002, ¶87.) A POSITA would have also understood that such AC voltage can be adjusted by using a transformer to a voltage suitable for the device to be powered. (Ex. 1002, ¶87; Ex. 1013, 161-162, 165-166.) Accordingly, a POSITA contemplating the above modified *Birrell-Logan* apparatus would have been motivated to, e.g., connect an AC mains to the 48V AC source providing power via the "first device" to provide a constant source of power, which would have been adjusted to an appropriate voltage for the apparatus (e.g., 120 V to 48 V) using known components, such as transformer or the like. (Ex. 1002, ¶87.) A POSITA would have found such a configuration beneficial because it would provide a known predictable source of power typically used in the types of applications contemplated by *Birrell* and *Logan*. (*Id.*; Ex. 1005, 4:24-38; Ex. 1006, 1:3-5, 2:1-6, 4:1-22.) A POSITA would have had a reasonable expectation of success implementing this feature given that use of 120V AC from the electrical grid and

use of a transformer to convert the AC power to a different/appropriate voltage were well known. (Ex. 1013, 161-162, 165-166; Ex. 1002, ¶87.) Indeed, the above modification would have been a mere combination of known components and technologies, according to known methods, to produce predictable results of providing power to the modified light system of *Birrell*. (Ex. 1002, ¶87; Ex. 1022, FIG. 2.1, ¶¶[0082]-[0084] (state of art).) *See KSR*, 550 U.S. at 416. Thus, the above-modified *Birrell-Logan* combination would have predictably resulted in the second device adapted to receive power from a power supply connected to an AC mains because the modified tile 50 receives power from the 48V AC power supply that is connected to the AC mains as modified above. (Ex. 1002, ¶87.)

3. Claim 4

a) The apparatus of claim 1, wherein said first device is configured to transmit power and data.

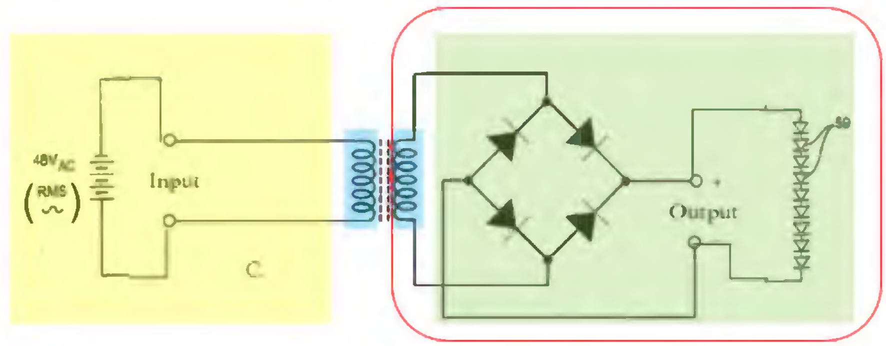
The *Birrell-Logan* combination discloses and/or suggests this feature. (Ex. 1002, ¶88.) The "first device" in the modified *Birrell-Logan* apparatus (Section IX.A.1(b)) transmits both data and power wirelessly because *Birrell* explains that its arrangement is "able to **provide both data and power through the electrical coupling** …." (Ex. 1005, 8:31-9:10; *id.*, 9:11-29, 13:15-23, 23:15-21 ("all data is transferred by the same electrical path that is used for the electrical power transfer").) *Logan* also discloses transmitting both power and data wirelessly through its inductive coupling. (Ex. 1006, 3:24-28, 5:18-6:2 ("**data can be superimposed on**

a carrier and transmitted through a panel" and "[t]wo-way transmission is possible"); Ex. 1002, ¶88.) Thus, a POSITA would have had the same skills, motivation, and expectation of success explained for claim 1 to configure the *Birrell-Logan* combination such that the first device providing power to the modified tile 50 ("second device") is also configured to transmit data consistent with the functionalities contemplated by *Birrell* and *Logan*. (Ex. 1002, ¶88; Sections IX.A.1(b)-(c).)

4. Claim 10

a) An apparatus comprising:

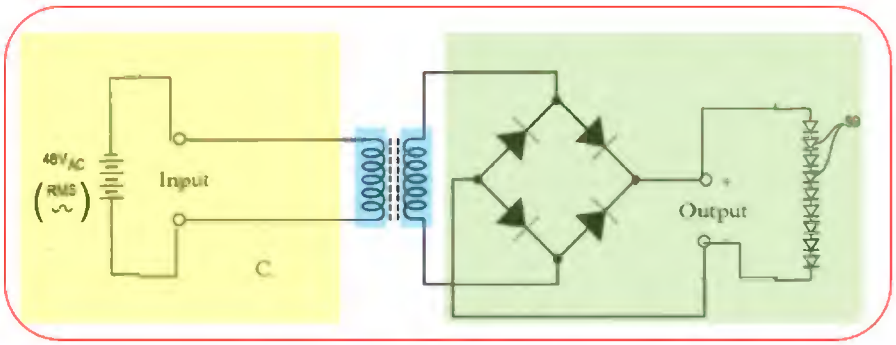
To the extent limiting, *Birrell*'s lighting tile 50 is an "apparatus." (Ex. 1005, 14:26-15:33; *supra* Section IX.A.1(a); *infra* Sections IX.A.4(b)-(e); Ex. 1002, ¶89.) Further, the *Birrell-Logan* combination (discussed below for limitation 10(e)) discloses the claimed apparatus in ***two ways***. (Sections IX.A.4(e), IX.A.1(b)) (modifying *Birrell*'s apparatus to include inductive coupling).) ***First***, as exemplified by the red box below, the modified lighting tile 50 in the discussed *Birrell-Logan* combination is an "apparatus" as claimed because it includes the features recited in limitations 10(b)-(e). (*Id.*; Sections IX.A.4(b)-(e); Ex. 1002, ¶89.)



Demonstrative A (annotated)

Second, as further exemplified in the red box below, the modified tile 50 with coils and the power supply device providing power (and interconnected circuitry and components) in the *Birrell-Logan* combination is an "apparatus." [12] (Ex. 1002, ¶89.)

[12] PO asserts a mobile phone "when used with a wireless charger" collectively "is an apparatus." (Ex. 1110, 2, 40; Ex. 1114, 2, 36.)



Demonstrative A (annotated)

b) an LED circuit comprising at least one LED;

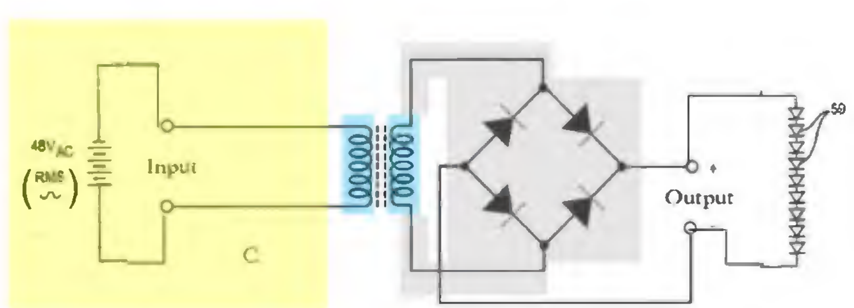
Birrell's tile 50 includes at least one LED 59. (Ex. 1005, 14:26-15:33; Ex. 1002, ¶90.) A POSITA would have understood that LEDs 59 in combination with other circuit components, e.g., the conductive wires connecting the LEDs and connections to receiver power (and thus current), is an "LED circuit," included in each of the above-identified "apparatus[es]. (Ex. 1002, ¶90; Section IX.A.4(a).)

c) a power supply, wherein said power supply is configured to provide power to the apparatus and is configured to receive power wirelessly from a power source;

The *Birrell-Logan* combination discloses and/or suggests this limitation in two ways. (Ex. 1002, ¶¶91-93.)

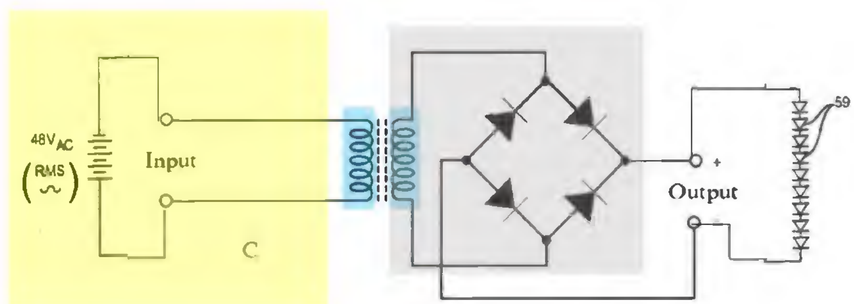
First, it would have been obvious to modify *Birrell* in view of *Logan* to provide inductive coupling for the reasons explained for limitations 1(b)-1(c) and

limitation 10(e) (Sections IX.A.1(b)-(c); IX.A.4(e); Ex. 1002, ¶92). In such a *Birrell-Logan* combination, the rectifier (diodes 67) and conductors connecting the receiving coil (e.g., grey below) discloses claim 10's "power supply" because it provides power to power LEDs 59 in the "apparatus." (Section IX.A.1(b); Ex. 1005, FIG. 8, 19:1-7 (diodes 67 form a bridge rectifier "ensur[ing] that light is emitted from the LEDs during both the positive and negative cycles of the AC power supply coupled via capacitors connections 66"); Ex. 1013, 163, 164-167 (bridge rectifier known to include a capacitor filter); Ex. 1001, 4:23, 9:57-65; Ex. 1002, ¶92.) In this way, each identified *Birrell-Logan* apparatus (limitation 10(a)) includes a "power supply" as claimed as it is configured to wirelessly receive power from a power source via its connection to the receiving coil that wirelessly receives power from the transmitting coil in the *Birrell-Logan* combination (*e.g.,* Ex. 1005, FIGS. 8, 10 (power supply 11)). (Ex. 1002, ¶92.)



Demonstrative D

Second, the rectifier (diodes 67), the receiving coil, and the conductors connecting the receiving coil in the modified tile 50 disclose the claimed "power supply" (e.g., grey below) because it provides power to LEDs 59 in the identified "apparatus" (limitation 10(a)) and is configured to receive power wirelessly (via receiving coil and conductors in the modified tile 50) from a power source (e.g., FIG. 8 (48V AC power source)) via the transmitting coil. (Ex. 1002, ¶93.)



Demonstrative E

d) a circuit configured to detect contact with a conductive substance for controlling at least the LED circuit; and

Birrell discloses this limitation for the same reasons above for claim limitations 1(c)(2) and 10(b) (describing that LEDs 59 in combination with other circuit components is a "LED circuit"). (*Supra* Sections IX.A.1(c)(2) and IX.A.4(b); Ex. 1002, ¶94.)

e) a data receiver, wherein said data receiver is configured to receive data from an antenna.

The *Birrell-Logan* combination discloses and/or suggests this limitation. (Ex. 1002, ¶¶95-96.) *Birrell* discloses that tile 50's circuitry is "structured so that all data is transferred by the same electrical path that is used for the electrical power transfer" (Ex. 1005, 23:15-21), where data are transmitted using a data modulator 80 and **received using a data demodulator 81** ("data receiver") (*id.*, 16:4-8, 23:22-29; FIG. 9 (below)). (Ex. 1002, ¶95.)

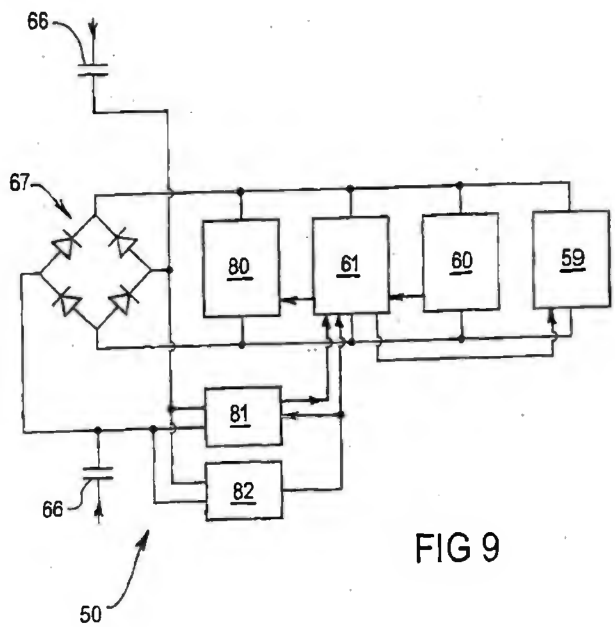


FIG 9

In the above *Birrell-Logan* combination, power and data are received using an inductive/receiving coil at the modified tile 50 in the form of an alternating electromagnetic field which is converted into an alternating current. (Ex. 1002, ¶96;

Ex. 1006, Abstract, 3:19-5:4; FIGS. 1-2; Ex. 1013, 161-166 (alternating current is generated through inductive coupling); Sections IX.A.1(b)-(c), IX.A.3, IX.A.4(a), IX.A.4(c).)) Thus, a POSITA would have understood that the receiving coil is an "antenna." (Ex. 1013, 110 ("[a] receiving antenna converts an electromagnetic (EM) field to an alternating current (AC)").) Given that data (and power) are received using the receiving coil ("antenna") in the modified tile 50, and the received data are demodulated using data demodulator 81 ("data receiver"), the *Birrell-Logan* combination discloses "a data receiver, wherein said data receiver is configured to receive data from an antenna." (Ex. 1002, ¶96.)

5. Claim 11

a) The apparatus of claim 10, wherein said circuit is configured to detect contact with the conductive substance via capacitive sensing.

The *Birrell-Logan* combination discloses/suggests this limitation for the reasons above for limitation 1(c)(2). (Section IX.A.1(c)(2); Ex. 1002, ¶97.)

6. Claim 12

a) The apparatus of claim 10, wherein said apparatus is configured to receive power from an AC mains power supply.

The *Birrell-Logan* combination discloses/suggests this limitation for the reasons above for claim 3. (Section IX.A.2; Ex. 1002, ¶98.)

7. Claim 13

a) An apparatus comprising:

To the extent limiting, *Birrell* alone or in combination with *Logan* discloses an "apparatus" for the reasons above for limitations 10(a) and 13(b)-(d). (Sections IX.A.4(a), IX.A.7(b)-(d); Ex. 1002, ¶99.)

b) a flat planar substrate upon which is mounted a plurality of LEDs;

Birrell discloses this limitation. (Ex. 1002, ¶100.) *Birrell* discloses that "mounted on the circuit board 58 includes nine LEDs 59." (Ex. 1005, FIG. 1, 15:18-21.) Given that *Birrell* discloses that the "preferred form of the present invention" is "a thin and generally **planar** lighting element" (*id.*, 13:15-17) and that *Birrell* describes that the lighting device is a "tile" (*e.g.*, *id.*, Abstract), a POSITA would have understood that *Birrell* discloses "a flat planar substrate upon which is mounted a plurality of LEDs," consistent with that shown in Figure 1 (LEDs 59 mounted on circuit board 58 (flat planar substrate). (*Id.*, FIG. 1; Ex. 1002, ¶100.) Such features would have been included in the modified tile 50 of the above the *Birrell-Logan* combination (Section IX.A.7(a).)

c) a data receiver, wherein the data receiver is configured to receive data from an antenna; and

The *Birrell-Logan* combination discloses/suggests this limitation for the reasons for limitations 10(a), 10(c), and 10(e). (Sections IX.A.4(a), IX.A.4(c), IX.A.4(e); Ex. 1002, ¶101.)

d) a circuit configured to detect contact with a conductive substance for controlling the plurality of LEDs.

The analysis for limitation 1(c)(2) explains how *Birrell* discloses the claimed "circuit," which would have been incorporated in the *Birrell-Logan* combination discussed above. (Sections IX.A.1(c)(2), IX.A.7(a)-(c); Ex. 1005, FIG. 1, 15:18-21 (lighting tile 50 including "nine LEDs 59"); Ex. 1002, ¶102.) For those reasons, the *Birrell-Logan* combination discloses limitation 13(d).

8. Claim 14

a) The apparatus of claim 13, wherein power is provided to said plurality of LEDs after said circuit detects the contact with the conductive substance.

Birrell alone or in combination with *Logan* discloses this limitation for the reasons discussed for limitation 1(c)(2) and those below. (Section IX.A.1(c)(2); Ex. 1002, ¶103.) *Birrell's* touch sensor "enable[s] the lighting tile 50 to be controlled" (Ex. 1005, 16:18-26) and that the lighting tile "includes integrally embedded electronic manual controls such as **touch switches or light level controls**" (*id.*, 8:4-7). A POSITA would have understood that switching on, or changing light levels

of, an LED involves providing power to the LED.[13] (Ex. 1002, ¶103.) *Birrell* discloses that the "LEDs [are]…coupled to an AC power supply" and the power supply "illuminate[s] the LEDs." (Ex. 1005, 20:26-31; *id.*, 8:31-9:10 (data/power provided "through the electrical coupling"), 22:29-30 (48 Volt AC power supply illuminates the LEDs).) Thus, *Birrell* discloses that "power is provided to said plurality of LEDs after said circuit detects the contact with the conductive substance." (Section IX.A.1(c)(2); Ex. 1005, FIG. 1, 15:21-33, 16:18-26; Ex. 1002, ¶103.) A POSITA would have found it obvious to implement such features in the *Birrell-Logan* combined apparatus for the reasons discussed above and because it would have maintained the functionalities disclosed by *Birrell.* (Sections IX.A.1(c)(2), IX.A.7(d); Ex. 1002, ¶103.)

9. Claim 15

a) The apparatus of claim 13, wherein said LEDs are organic LEDs.

Birrell discloses this limitation as it discloses using "organic polymer LED materials" as light sources, which would have been implemented in the *Birrell-Logan* combination discussed above in claim 13 for the same reasons. (Ex. 1005, 11:35-12:3; Section IX.A.7; Ex. 1002, ¶104.)

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[13] PO alleges that "turn[ing] on" LEDs corresponds to the claimed "power is provided to said plurality of LEDs." (Ex. 1110, 25; Ex. 1114, 23.)

10. Claim 17

a) An apparatus comprising:

To the extent limiting, *Birrell* discloses this preamble for the reasons discussed for limitation 10(a). (Section IX.A.4(a); *infra* Sections IX.A.10(b)-(e); Ex. 1002, ¶105.)

b) an LED circuit comprising at least one LED;

Birrell discloses this limitation for the reasons discussed for limitation 10(b). (Section IX.A.4(b); Ex. 1002, ¶106.)

c) a circuit configured to detect contact with a conductive substance for at least controlling the LED circuit; and

Birrell discloses this limitation for the reasons discussed for limitations 1(c)(2) and 10(d). (*Supra* Sections IX.A.1(c)(2), IX.A.4(d); Ex. 1002, ¶107.)

d) a data receiver, wherein said data receiver is configured to receive data from an antenna,

The *Birrell-Logan* combination discloses/suggest this limitation for the reasons above for limitations 10(a), 10(c), and 10(e). (Sections IX.A.4(a), IX.A.4(c), IX.A.4(e); Ex. 1002, ¶108.)

e) wherein said apparatus is portable.

The *Birrell-Logan* combination discloses/suggests that the "apparatus" is portable. (Ex. 1002, ¶109.) *Birrell* discloses that tile 50 may be conveniently "removed from a supporting structure." (Ex. 1005, 15:8-14; *id.*, 2:14-35 (*Birrell*

solves problems associated with fixed lighting devices).) *Birrell* also discloses that the lighting tile may be implemented on an "advertising display, or a piece of furniture such as a table surface [for reading purposes]." (Ex. 1005, 4:24-32.)[14] Thus, the combined *Birrell-Logan* apparatus would likewise have been "portable." (Ex. 1002, ¶109.)

11. Claim 18

a) An apparatus comprising:

To the extent limiting, *Birrell* discloses an "apparatus" for the reasons discussed for limitation 10(a). (Section IX.A.4(a); Ex. 1005, 14:26-15:33; *infra* Sections IX.A.11(b)-(d); Ex. 1002, ¶110.)

b) a flat planar substrate upon which is mounted a plurality of LEDs;

Birrell discloses this limitation for the reasons discussed for limitation 13(b). (Section IX.A.7(b); Ex. 1002, ¶111.)

c) a transmission conductor configured to provide data and power to said apparatus; and

Birrell discloses this limitation. (Ex. 1002, ¶¶112-113.) As explained and exemplified below, lighting tile 50 ("apparatus") includes a "transmission

[14] PO alleges that large appliances, e.g., refrigerators, are "portable." (Ex. 1110, 116; Ex. 1114, 104.)

conductor," which receives wireless power from the power supply and provides power to the LEDs. (Section IX.A.1(c)(3); Ex. 1005, FIG. 8 (annotated below); Ex. 1002, ¶112.)

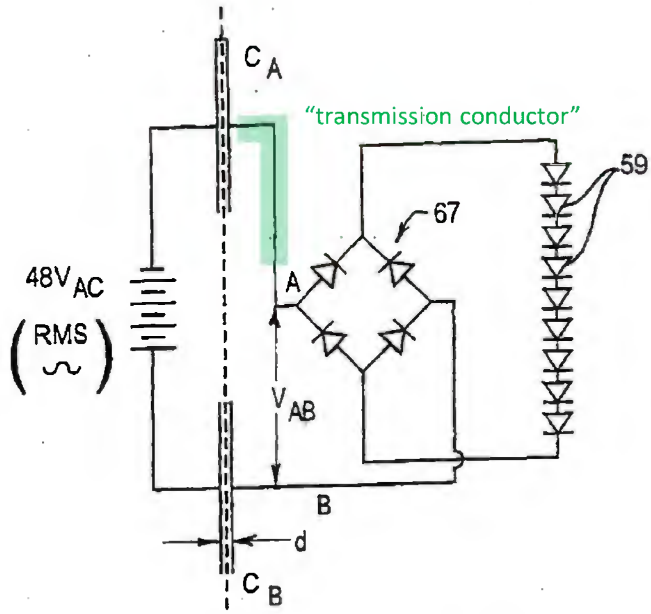


FIG 8

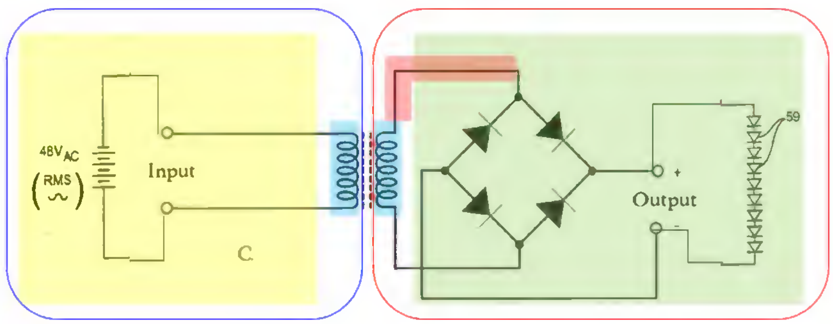
Birrell discloses that "all data is transferred by the same electrical path that is used for the electrical power transfer" (Ex. 1005, 23:15-21) and that this configuration is "able to provide both data and power through the electrical coupling" (*id.*, 8:31-9:10). (Section IX.A.3.) Thus, the "transmission conductor" provides power and data to tile 50 ("apparatus" (including as modified below with *Logan*)). (Ex. 1002, ¶113; Section IX.A.11(a).)

d) a data receiver, wherein the data receiver is configured to receive the data from the transmission conductor or an antenna and the power from the transmission conductor.

The *Birrell-Logan* combination discloses or suggests the data receiver receives the data from an antenna and power from the above "transmission conductor." (Ex. 1002, ¶¶114-115.) The analysis for limitations 1(b)-1(c) explains how/why a POSITA would have found it obvious in view of *Logan* to configure *Birrell* to utilize inductive coupling to transmit power to tile 50 ("apparatus"). (Sections IX.A.1(b)-(c).) Furthermore, the analysis for limitation 10(e) explains how the modified tile 50 in the *Birrell-Logan* combination includes data demodulator 81 ("data receiver") configured to receive data and power from the receiving coil, which is an "antenna." (Section IX.A.4(e).) Thus, the *Birrell-Logan* combination discloses/suggests limitation 18(d) where the data receiver is configured to receive the data from an "antenna" (receiving coil). (Ex. 1002, ¶114.)

Moreover, the "transmission conductor" (limitation 18(c)) would likewise provide the power to the "data receiver" in the *Birrell-Logan* combination for similar reasons. Indeed, as explained (Section IX.A.1(c)(3)), the transmission conductor in the modified tile 50 would be connected to the receiving coil and thus would receive data and power, which would have been provided to tile 50's components, including demodulator 81 ("data receiver"), as exemplified below ("apparatus" (red box)

including demodulator 81 (above), antenna (right blue coil)), transmission conductor (red line)). (Section IX.A.11(c); Ex. 1005, 23:15-29, FIG. 9; Ex. 1002, ¶115.)



Demonstrative B

12. Claim 19

a) The apparatus of claim 18, wherein the LEDs are Organic LEDs.

Birrell discloses this limitation for the reasons discussed for claim 15. (Section IX.A.9; Ex. 1002, ¶116.)

13. Claim 20

a) The apparatus of claim 18, wherein said apparatus further comprises a MODEM.

Birrell discloses this limitation. (Ex. 1002, ¶117.) *Birrell* discloses that "the light tile circuitry is structured so that all data is transferred by the same electrical path…used for…power transfer," where data are transmitted using **a data modulator 80** and received using **a data demodulator 81** (collectively the claimed "MODEM") (Ex. 1005, 23:15-29). (Ex. 1002, ¶117; Ex. 1017, 2:19 ("**modem** or

modulator-**dem**odulator"); Ex. 1001, 23:53-60 (data signal receiver 2078 can be a modem).)

14. Claim 21

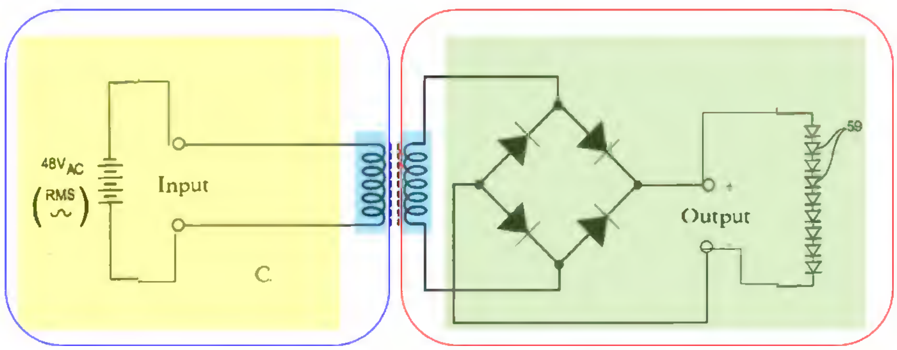
a) A system comprising:

To the extent limiting, *Birrell* (as modified below) discloses a "system" for the similar reasons discussed for limitation 1(a) and below. (Section IX.A.1(a).) *Birrell* discloses a lighting system ("system") that includes lighting tile 50 ("first device" (below for limitation 21(b)) and a device ("second device" below for limitation 21(c)) having an AC power supply to provide power to tile 50 in context of the combination of *Birrell-Logan*. (*Infra* Sections IX.A.14(b)-(c); Ex. 1002, ¶118.)

b) a first device, wherein the first device includes (a) at least one LED, (b) at least one antenna, (c) at least one data communications circuit, and (d) at least one battery, and wherein the first device is configured to detect contact with a conductive substance via capacitive sensing for controlling at least the at least one LED; and

Birrell in view of *Logan* discloses/suggests this limitation. (Ex. 1002, ¶¶119-120.) A POSITA would have found it obvious to configure *Birrell's* lighting system and thus tile 50 to include inductive coupling to wirelessly receive power and data signals in light of *Logan* for reasons discussed for limitations 1(b)-(c) and claims 10, 13, 17-18 (Sections IX.A.1(b), IX.A.1(c), IX.A.4, IX.A.7, IX.A.10-11; Ex. 1002,

¶119.) The modified tile 50 ("first device" (e.g., red box below)) in the *Birrell-Logan* combination would have included "at least one antenna" (e.g., receiving coil) and "at least one data communications circuit" (e.g., demodulator 81)[15] as claimed for the reasons explained for limitations 10(e), 13(c), 17(d), and/or 18(d). (Sections IX.A.4(e), IX.A.7(c), IX.A.10(d), IX.A.11(d); Ex. 1002, ¶119.)



Demonstrative F

Modified tile 50 ("first device") includes at least one LED (LEDs 59) and is configured to detect contact with a conductive substance via capacitive sensing for controlling at least the at least one LED for the reasons discussed for claim limitations 1(c)(1)-1(c)(2). (Sections IX.A.1(c)(1)-(2).) Furthermore, the modified

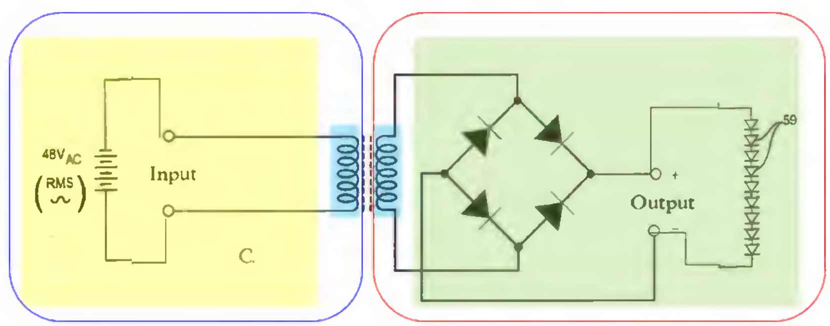
[15] Modulator 80 alone or collectively with demodulator 81 is also a "data communication circuit." (Ex. 1002, ¶¶119-120; Ex. 1005, 16:4-8, 23:22-29; FIG. 9.)

"first device" would have also included "at least one battery" given *Birrell* explains that lighting tile 50 includes "energy storage components," which a POSITA would have understood is a battery and would have been incorporated in the *Birrell-Logan* combination. (Ex. 1005, 15:34-16:10; Ex. 1002, ¶120.) And even if such components were not considered a battery, *Birrell*'s disclosures would have motivated a POSITA to configure the modified tile 50 to include a battery to achieve the benefit of providing portable power source for the tile. (Ex. 1002, ¶120; *infra* Section IX.G.1(e) (regarding reasons/motivations to configure the "energy storage components" with a rechargeable battery to provide power, incorporated/applicable here).) Thus, it would have been obvious to implement such a battery in tile 50 as such a modification would have been within the skills of a POSITA who would have recognized the benefits of such a configuration and had a reasonable expectation of success in such an implementation (especially in light of *Birrell*'s "energy storage components" disclosures). (Ex. 1002, ¶120.)

c) a second device, wherein the second device is configured to transmit power and signals wirelessly to the first device.

The *Birrell-Logan* combination discloses/suggests this limitation for reasons discussed for claim 4. (Section IX.A.3 (where claim 4's mapped "first device" is the same as claim 21(c)'s "second device" in the *Birrell-Logan* combination); Ex. 1002, ¶121.) As explained, the second device in the *Birrell-Logan* combination

(e.g., blue box below) would have been configured to transmit power and data through inductive coupling ("transmit power and signals wirelessly") to the modified lighting tile 50 (red box ("first device")) in the combination. (Section IX.A.3; Ex. 1002, ¶121; Section IX.A.1.)



Demonstrative F

15. Claim 23

a) The apparatus of claim 1, wherein the conductive substance includes a metallic material.

Birrell discloses this limitation in two ways. (Ex. 1002, ¶¶122-124.) **First**, as discussed above for limitation 1(c)(2), *Birrell* discloses that lighting tile 50 includes a "**metallised polymer film 64**" ("conductive substance") which "acts as a touch sensor." (Ex. 1005, 16:18-26; Section IX.A.1(c)(2).) A POSITA would have understood that the "metallised" film includes "a metallic material," and thus the touch sensor circuit in *Birrell* detects contact with a conductive metallic material

substance.[16] (Ex. 1002, ¶122.) Such features would have been implemented in the *Birrell-Logan* combination for the same reasons explained for claim 1. (*Id.*; Section IX.A.1.)

Second, to the extent that the claim refers to a metallic material conductive substance making contact with the second circuit, it would have been obvious to configure the *Birrell-Logan* "apparatus" (claim 1) to allow the touch sensor components of *Birrell* to detect contact from a stylus or similar device having metallic material. (Ex. 1002, ¶123.) A POSITA would have been motivated to make such a modification given *Birrell* discloses that its capacitive touch sensor is capable of detecting touch. (Ex. 1005, 16:18-26; Ex. 1002, ¶123; Ex. 1001, 20:30-36.) A POSITA would have appreciated the many ways capacitive touch sensing can be facilitated (e.g., other types of conductive substances for making contact with a sensor) and that *Birrell*'s sensor was likewise capable of detecting contacts with other conductive substance(s), such as metal-containing input devices. Indeed, *Birrell* recognizes that metal wires or the like were a common conductive material(s), which may form elements of capacitive coupling. (Ex. 1005, 14:33-37.) It was also known in the state of art that metal-containing styluses/pointing devices

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[16] PO has alleged touch screen features for this limitation. (Ex. 1110, 4, 38, 42, 73, 76, 101.)

were used in capacitive contact sensing applications. (Ex. 1002, ¶123; Ex. 1014, FIGS. 1, 4-6, 8:18-19 (tip 62 of stylus 30 is made of a metal), 7:66-8:11, Ex. 1020, ¶¶[0018] ("conductive stylus"), [0006], [0038], [0046], [0065]; Ex. 1021, 4:65-5:6 (disclosing that a stylus, e.g., an input pen includes a "conductive pen tip" and "[a] metallic shield member").) Accordingly, a POSITA would have been aware of such known features and thus been motivated, with a reasonable expectation of success, to configure the *Birrell-Logan* "apparatus" such that the "second circuit" was configured to also detect contact (for controlling the LED(s)) with a metallic material containing stylus or similar device, to expand the versatility of the modified system. (Section IX.A.1(c)(2); Ex. 1002, ¶123.)

Such a modification would have been a predictable implementation of known technologies and techniques (capacitive touch sensor technologies) that would have resulted in a foreseeable circuit that allowed the touch circuit to accommodate different applications and uses by users of the lighting device. (Ex. 1002, ¶124.) For example, a POSITA would have appreciate the benefits in expanding the functionality of the *Birrell-Logan* device to accommodate applications where a user may need/desire to use an extension/pointer or similar device to make contact with tile 50 for controlling the LEDs, which may be helpful where tile 50 is positioned in locations difficult for a user to reach with their outreached hands, and/or where a user wishes to avoid making personal contact with tile 50 (e.g., that is also operated

by others) for personal hygiene reasons. (*Id.*) Configuring the touch circuitry in the combined apparatus to detect contact from a stylus/pointer that contains a metallic material (e.g., at the tip, etc.) would have been an obvious design configuration from which a POSITA would have been able to select from given the known ways to implement capacitive touch sensing systems/devices/components. (*Id.*)

B. Ground 2: Claim 2 Is Obvious Over *Birrell*, *Logan*, and *Johnson*

1. Claim 2

a) The apparatus of claim 1, wherein said first device[17] comprises at least one colored LED.

Birrell in view of *Logan* and *Johnson* discloses and/or suggests this limitation. (Ex. 1002, ¶¶125-129.) While *Birrell* (as modified) does not expressly disclose that the "**first device** comprises at least one colored LED," a POSITA would have nonetheless found it obvious to implement such features in view of *Johnson*. (Ex. 1002, ¶126.)

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[17] PO has alleged that its mapped "second device" (not the "first device"), including the claimed LEDs, meets this limitation. (*E.g.*, Ex. 1110, 3, 6.) To the extent claim 2 is interpreted such that the second device's LEDs comprises a colored LED, the modified tile 50 in the *Birrell-Logan* apparatus ("second device") includes LEDs 59 that have different colors. (Ex. 1005, 12:4-21, 14:26-15:33, FIG. 8).)

Like *Birrell*, *Johnson* discloses a power delivery device, i.e., a battery charger. (Ex. 1007, 1:58-2:2.) As such, a POSITA implementing the system of *Birrell* would have had reason to consider the teachings of *Johnson*. (Ex. 1002, ¶127.) *Johnson* discloses that the power delivery device includes "[t]wo bicolor light emitting diodes (LEDs) 109 and 111" as indicators for signifying status and/or rate of power delivery (*id.*, 2:11-22) connectivity status to a battery for charging (*id.*, 6:55-60). (Ex. 1002, ¶127.)

A POSITA would have been motivated to implement at least one colored LED, similar to as disclosed in *Johnson*, in the "first device" in the *Birrell-Logan* combination to provide status indications of operation associated with the AC power supply. (Ex. 1002, ¶128.) A POSITA would have appreciated that a colored LED indicator would have allowed a user to quickly and efficiently determine the status of the power being delivered to tile 50 (e.g., indicate whether the AC power supply is operational or properly receiving/providing power). (Ex. 1002, ¶128.) Such implementation would have been beneficial as *Birrell* discloses that the lighting system is not limited to those mounted on the wall or ceilings, but may also be used in other settings where a user would have access to the AC power supply and first device to determine such status. (Ex. 1005, 4:20-32; *id.*, 2:8-13; Ex. 1002, ¶128.)

A POSITA would have had the capability, and a reasonable expectation of success in implementing, *Johnson*'s teachings/suggestions in a system like the

Birrell-Logan combination because, e.g., colored LEDs were commercially available and the circuitry to implement such LEDs were well-known. (Ex. 1002, ¶129; Ex. 1007, 6:51-60; Ex. 1013, 165-166; Ex. 1005, FIG. 8; Ex. 1006, FIG. 2.) Furthermore, the use of LED indicators for a power delivery device was also well-known. (Ex. 1018, 3:41-51; Ex. 1022, ¶[0087].) The above-described implementation would have involved the use of known technologies and techniques (e.g., use of colored LED status indicators) to yield the predictable result of the modified first device providing operational and/or power delivery status indications for ease of use. (Ex. 1002, ¶129.) *See KSR*, 550 U.S. at 416.

C. Ground 3: Claims 3, 10-12, and 21 Are Obvious Over *Birrell*, *Logan*, and *Zhang*

1. Claim 3

a) The apparatus of claim 1, wherein said second device is adapted to receive power from a power supply connected to an AC mains.

Section IX.A.2 explains how the *Birrell-Logan* combination discloses/suggests claim 3. (Section IX.A.2; Ex. 1002, ¶¶130-135.) However, to the extent that the *Birrell-Logan* combination does not itself support the obviousness of such a modification, *Zhang* further supports that a POSITA would have been motivated, and found obvious, to configure the *Birrell-Logan* apparatus to couple an AC mains to a power supply that provides power received by the modified tile 50 ("second device"). (Ex. 1002, ¶131.)

Zhang discloses a power supply providing power to LEDs. (Ex. 1022, ¶¶[0082]-[0084] (disclosing with reference to Figure 2.1 that a 9V AC power supply, through a rectifier 35, is used to power an array of LEDs 19), FIG. 2.1; Ex. 1002, ¶132.)

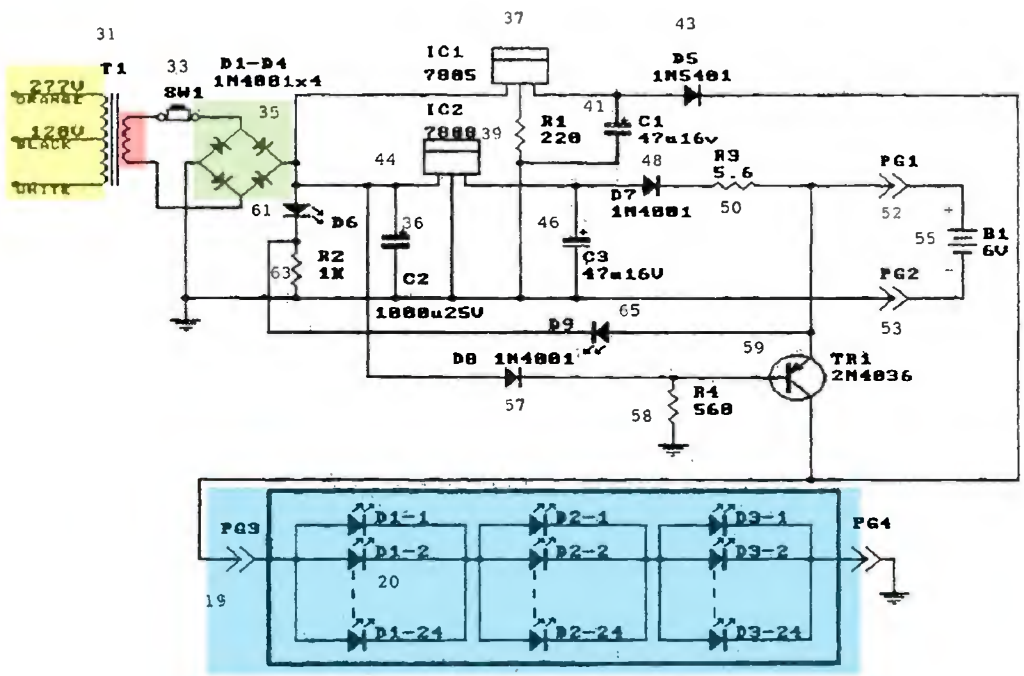

FIG. 4 <EXIT> SIGN
CIRCUIT DIAGRAM

Fig. 2.1, Electronic Circuit Board for LED Exit Sign

(Ex. 1022, FIG. 2.1 (120V AC (yellow), 9V AC (red), rectifier 35 (green), and LEDs 19 (blue)); Ex. 1002, ¶132.) Thus, a POSITA would have had reason to consider the teachings of *Zhang* when implementing the system of *Birrell*. (Ex. 1002, ¶132.) *Zhang* discloses that the 9V AC is derived from the 120V AC, which is from the

commercial line or electrical grid ("AC mains") by using a transformer 31. (Ex. 1022, ¶[0083]; Ex. 1002, ¶132.)

Based on the guidance by *Zhang*, a POSITA would have found it obvious to modify the *Birrell-Logan* combination to connect the 48V AC power supply (similar to as described in *Birrell*) to a 120V AC commercial line such that it draws power from the electrical grid. (Ex. 1002, ¶133.) Indeed, consistent with that demonstrated by *Zhang*, a POSITA would have understood that 120V AC power from the electrical grid is commonly used, conveniently providing power to lighting fixtures and other electronics. (Ex. 1013, 157 (120V AC powering lighting fixtures); Ex. 1024, 1:9-28, 1:35-48, FIG. 1; Ex. 1025, 1:10-25, FIG. 1; Ex. 1002, ¶133.) Furthermore, even if an electronic device does not use 120V AC directly, a POSITA would have understood that the AC voltage can be adjusted by using a transformer, similar to as disclosed in *Zhang*, to a voltage suitable for the electronic device to be powered. (Ex. 1022, ¶[0083]; Ex. 1013, 161-162, 165-166; Ex. 1002, ¶133.)

A POSITA thus would have been motivated, with a reasonable expectation of success, to configure the second device in the *Birrell-Logan* combination (claim 1) to be adapted to receive power from a power supply connected to an AC mains for reasons above and those discussed in Section IX.A.2. (Section IX.A.2; Ex. 1022, ¶[0083]; Ex. 1013, 161-162, 165-166; Ex. 1002, ¶134.) Indeed, the above configuration would have been a mere combination of known components and

technologies, according to known methods, to produce predictable results. (*Id.*) *See KSR*, 550 U.S. at 416.

The *Birrell-Logan-Zhang* combination discloses this limitation in another way. (Ex. 1002, ¶135.) As discussed below for claim 21, a POSITA would have found it obvious to include a rechargeable battery ("power supply") in the modified lighting tile 50, where the battery is charged by AC mains power during normal operation, and when the AC mains power is interrupted, the battery powers the modified lighting tile 50. (*Infra* Section IX.C.2; Ex. 1002, ¶135.) Accordingly, for those reasons, the modified lighting tile 50 ("second device") in the *Birrell-Logan-Zhang* combination would have been adapted to receive power from a rechargeable battery (a "power supply") that is charged by an AC mains ("a power supply connected to an AC mains"). (*Id.*)

2. Claim 21

As explained in Ground 1, the *Birrell-Logan* combination discloses/suggests the limitations of claim 21. (Section IX.A.14; Ex. 1002, ¶¶136-140.) However, to the extent that the *Birrell-Logan* combination is found not to disclose that "the first device" includes "at least one battery" as explained for claim 21 (Ground 1), it would have been obvious to implement a battery in the modified tile 50 ("first device") in the *Birrell-Logan* combination in view of *Zhang*. (Ex. 1002, ¶¶136-137.)

Zhang discloses a power supply providing power to LEDs. (Ex. 1022, ¶¶[0082]-[0084].) *Zhang* additionally discloses "a battery 55," where the power supply derives from the 120V AC power to charge the battery during normal operations and when the AC power is interrupted, battery 55 provides power to the LEDs. (Ex. 1022, ¶¶[0082]-[0087], FIG. 2.1; *see also id.*, Abstract, ¶¶[0036], [0054], [0094], [0109]; Ex. 1002, ¶138.)

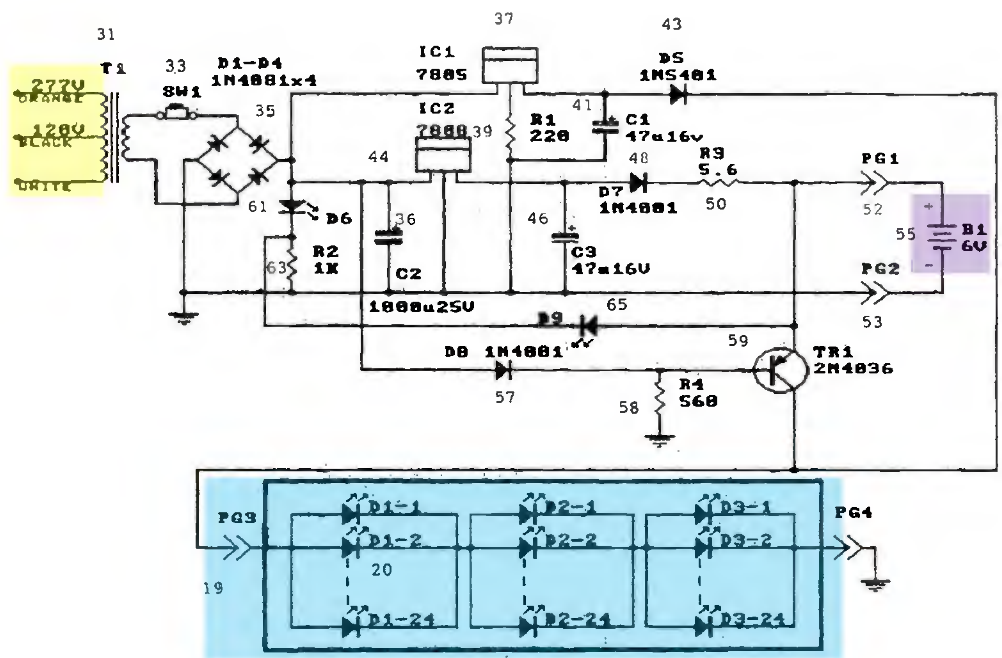

FIG. 4 <EXIT> SIGN
CIRCUIT DIAGRAM

Fig. 2.1, Electronic Circuit Board for LED Exit Sign

(Ex. 1022, FIG. 2.1 (120V AC in yellow, LEDs 19 in blue, and battery 55 in purple); Ex. 1002, ¶138.)

A POSITA would have found it obvious and beneficial to include a rechargeable battery in the modified lighting tile 50 of the *Birrell-Logan* combination that would be charged using AC mains power (e.g., 120/220 VAC), during normal operation. (Ex. 1002, ¶139.) Indeed, consistent with that described in *Zhang*, a POSITA would have found it beneficial to include such a battery as it would have provided backup power to the apparatus, which ultimately ensures that the LEDs in lighting tile 50 would provide continuous illumination, particularly during emergency situations, e.g., fire and earthquake, when the AC mains power is unavailable. (Ex. 1002, ¶139; Ex. 1022, ¶¶[0082]-[0087]; *id.*, ¶[0036]; Section IX.C.1.) Furthermore, a POSITA would have been motivated to use a rechargeable battery as it would have allowed repeated uses and charges by use of the AC mains power when available. (Ex. 1002, ¶139; Ex. 1022, ¶[0036].)

A POSITA would have had the capability and motivation, with a reasonable expectation of success, to implement a rechargeable battery in the *Birrell-Logan* combination, given that it was known to use battery as portable and/or backup power. (Ex. 1011, FIG. 7; Ex. 1022, FIG. 2.1; Ex. 1002, ¶140.) Such implementation would have involved applying known technologies and techniques (e.g., use of a rechargeable battery in a lighting device) to yield the predictable result of implementing a rechargeable battery in the modified tile for use as a backup power when main power is interrupted. (Ex. 1002, ¶140.) *See KSR*, 550 U.S. at 416.

3. Claims 10-12

The *Birrell-Logan* combination modified in view of *Zhang* also discloses/suggests **claim 10**. (Ex. 1002, ¶¶141-145.)

Namely, while Section IX.A.4(c) explains how *Birrell* discloses a "power supply" as claimed, it would have been obvious to configure the modified tile 50 in the *Birrell-Logan* "apparatus" (Section IX.A.4) to include a rechargeable battery ("power supply") to provide power to the apparatus in view of *Zhang* as discussed in claim 21 above in Ground 3. (*Supra* Section IX.C.2; Ex. 1002, ¶142.) Further, for similar reasons and in light of the state of the art, it would have been obvious to configure such a rechargeable battery to also be recharged wirelessly to provide additional versatility and benefits known to be achieved through such features. (Ex. 1002, ¶142.) A POSITA would have appreciated that enabling the rechargeable battery in the modified tile 50 to be charged wirelessly (and via AC mains (*supra* Sections IX.C.1-2; Ex. 1022, ¶[0036])) would have provided a user friendly and efficient way of sustaining power to the rechargeable battery in the *Birrell-Logan-Zhang* modified tile 50 discussed above. (Ex. 1002, ¶142.) Indeed, it was known in the art that wirelessly recharging mechanisms/configurations for devices (including portable devices) provided benefits to existing devices (including portable ones) (*Id.*; Ex. 1112, 1:7-57, 7:5-8:10; Ex. 1092, ¶¶[0198]-[0200] ("[a] power facility 1800" of a lighting system "may include a battery" where "power facility 1800 can include

an inductive charging facility" to "charge an onboard power source").) A POSITA would have thus found providing such features with the rechargeable battery in the *Birrell-Logan-Zhang* modified tile 50 beneficial as it would have provided alternate ways to maintain the battery life. A POSITA would have had the same capabilities and expectation of success to implement such features as described above for modifying tile 50 to include a rechargeable battery. (Section IX.C.2; Ex. 1002, ¶142.)

Claim 11 is disclosed/suggested by the *Birrell-Logan-Zhang* combination for the reasons explained in Section IX.A.5. (Ex. 1002, ¶143.)

As to **claim 12**, to the extent that *Birrell* is read not to disclose or suggests this limitation (Ground 1, Section IX.A.6), *Birrell* in view of *Logan* and *Zhang* discloses this limitation for the reasons discussed above for claims 3 and 21 above. (*Supra* Sections IX.C.1-2; Ex. 1002, ¶¶144-145.) Moreover, it would have been obvious to configure the modified tile 50 in the *Birrell-Logan-Zhang* combination discussed above to receive power from an AC mains power supply for reasons similar to those explained for claims 3, 10, and 21 above (Sections IX.C.1-3). (Ex. 1002, ¶¶144-145.) For similar reasons, a POSITA would have been motivated (with a similar expectation of success) to allow the rechargeable battery in the modified tile 50 to be wirelessly charged (e.g., from power provided via the AC mains) to ensure the

rechargeable battery would be able to serve as a backup power supply for extended periods of AC main power interruptions. (*Id.*)

D. Ground 4: Claim 5 Is Obvious Over *Birrell*, *Logan*, and *Sembhi*

1. Claim 5

a) The apparatus of claim 1, wherein said second device comprises a three-way switch.

Birrell in view *Logan* and *Sembhi* discloses and/or suggests this limitation. (Ex. 1002, ¶¶146-150.) *Birrell* discloses that lighting tile 50 includes "integrally embedded electronic manual controls such as touch switches or light level controls, remote controls such as radio frequency or infra-red, automatic controls" (Ex. 1005, 8:4-30), but *Birrell* does not expressly disclose that lighting tile 50 includes a "three-way switch." Nevertheless, a POSITA would have found it obvious to implement such feature in the modified tile 50 of the *Birrell-Logan* combination in view of *Sembhi*. (Ex. 1002, ¶147.)

Like *Birrell*, *Sembhi* discloses a lighting device controller, e.g., a switch, for controlling the light intensity level. (Ex. 1008, Abstract.) Thus, a POSITA would have had reason to consider *Sembhi* when implementing the system of *Birrell*. (Ex. 1002, ¶148.) *Sembhi* discloses that it was known to implement three-way switches, which allows an additional light control "at another location." (Ex. 1008, ¶[0018].) *Sembhi* explains that such a three-way switch would also allow using radio frequency signals to control the lighting. (*Id.*; Ex. 1002, ¶148.)

A POSITA would have been motivated to implement a three-way switch in the modified tile 50 to allow the device to provide or work with three-way switch designs that allow a user to control the lighting device from multiple locations. (Ex. 1002, ¶149.) Indeed, the use of three-way switches to allow users to control lighting devices from different locations was known to a POSITA at the time, and providing similar functionalities with the modified tile 50 of the *Birrell-Logan* apparatus would have been a straightforward and predictable application of such common technologies and features. (Ex. 1019, 1:11-18; Ex. 1023, 3:66-4:10 (disclosing use of two three-way switches to control a lighting device), 5:12-32 (same); FIG. 4; Ex. 1002, ¶149.) Given such knowledge, a POSITA would have been motivated to implement a three-way switch at the modified lighting tile 50 that would operate with another three-way switch at a location different from the lighting tile, to provide similar functionality (e.g., allow a user to turn on/off tile 50 from different locations). (Ex. 1002, ¶149.) A POSITA would have the capability and reasonable expectation of success in implementing a three-way switch in a system given that implementing three-way switches for lighting circuits was "well known." (Ex. 1019, 1:11-18; Ex. 1002, ¶¶149-150.) Indeed, *Birrell* itself discloses that the lighting device can be controlled remotely using radio frequency, similar to as disclosed in *Sembhi*. (Ex. 1005, 8:4-14; Ex. 1011, ¶[0018].) *See KSR*, 550 U.S. at 416.

E. Ground 5: Claims 6, 18, and 24 Are Anticipated by *Birrell*

1. Claim 6

a) A method of operating an apparatus, the method comprising:

To the extent limiting, *Birrell* discloses this preamble for reasons above for limitation 1(a), 10(a) (showing operation of tile 50 or the lighting system with tile 50 (each an "apparatus"). (Sections IX.A.1(a) and IX.A.4(a); Sections IX.E.1(b)-(e); Ex. 1002, ¶¶151-152.)

b) receiving power wirelessly in the apparatus;

Birrell discloses this limitation. (Ex. 1002, ¶153.) For example, *Birrell* discloses that lighting tile 50 receives power wirelessly through capacitive coupling. Figure 8 describes a device with an AC power supply that is capacitively coupled to tile 50 and transmits wireless power to tile 50 via capacitors C_A and C_B to ultimately power LEDs 59. (Ex. 1005, FIGS. 1 and 8, 2:36-3:16, 3:17-27 (device "coupled to the power source without requiring any direct connection"), 14:26-15:33, 20:26-31; 21:34, 22:29-30 ("a 48 Volt AC power supply…will satisfactorily illuminate the LED's of Figure 8"), 23:2-11).) Such functionality discloses limitation 6(b). (Ex. 1002, ¶153.)

c) transmitting or receiving data signals wirelessly;

Birrell discloses this limitation. (Ex. 1002, ¶154.) A device including the power supply transmits both data and power wirelessly and tile 50 receives the same.

(Ex. 1005, FIG. 8, 8:31-9:10 ("**provid[ing] both data and power through the electrical coupling**…."), 9:11-29, 13:15-23 ("lighting elements may be controlled by data transmitted with the power supply"), 23:15-21 ("all data is transferred by the same electrical path…used for the electrical power transfer," where "data is superpositioned on the primary power.").) Such functionality discloses limitation 6(c). (Ex. 1002, ¶154; *see also* Section IX.E.1(b).)

d) detecting contact with a conductive substance via capacitive sensing; and

Birrell discloses this limitation for the same reasons discussed above for claim limitation 1(c)(2), which describes the operations of detecting such contact like that claimed in limitation 6(d) in relation to the touch sensor component in tile 50. (Section IX.A.1(c)(2); Ex. 1002, ¶155.)

e) increasing a level of power to an LED circuit comprising at least one LED in the apparatus after detection of the contact.

Birrell discloses this limitation for the same reasons discussed above for claim limitation 10(b) ("an LED circuit comprising at least one LED") and claim 14 ("power is provided to said plurality of LEDs after said circuit detects the contact with the conductive substance"). (Sections IX.A.4(b), IX.A.8; Ex. 1002, ¶156.) As explained in those sections, providing power to the LED circuit (and LEDs) after contact detection results in increasing the level of power to the LED circuit to

illuminate the LEDs in a manner consistent with *Birrell*'s disclosures and that recited in limitation 6(e). (*Id.*)

2. Claim 18

a) Claim Preamble 18(a)

To the extent limiting, *Birrell* discloses this preamble for the reasons above for limitation 10(a) (tile 50 being an "apparatus"). (Section IX.A.4; Section IX.A.11; *infra* Sections IX.E.2(b)-(d); Ex. 1002, ¶157.)

b) Claim limitation 18(b)

Birrell discloses this limitation for the reasons above for limitation 13(b), which explains how tile 50 ("apparatus") includes the claimed "flat planar substrate" as recited in limitation 18(b). (Section IX.A.7(b); Ex. 1002, ¶158.)

c) Claim limitation 18(c)

Birrell discloses this limitation for the reasons above for limitation 18(c) in Ground 1. (Section IX.A.11(c); Ex. 1002, ¶159.)

d) Claim limitation 18(d)

Birrell discloses this limitation. (Ex. 1002, ¶160.) As discussed in Section IX.A.11(d) (limitation 18(d), Ground 1), *Birrell* discloses a "data receiver" (data demodulator 81 of tile 50). (Section IX.A.11(d).) *Birrell* also discloses a "transmission conductor" in tile 50 providing both data and power to the "data receiver." (*Id.*; Ex. 1005, FIG. 9 (annotated below), 23:15-21 ("the light tile circuitry is structured so that all data is transferred by the same electrical path that is used for

the electrical power transfer"), 23:22-29 (data transmitted via modulator 80 and data received by demodulator 81 ("data receiver") via the transmission conductor); Ex. 1002, ¶160.)

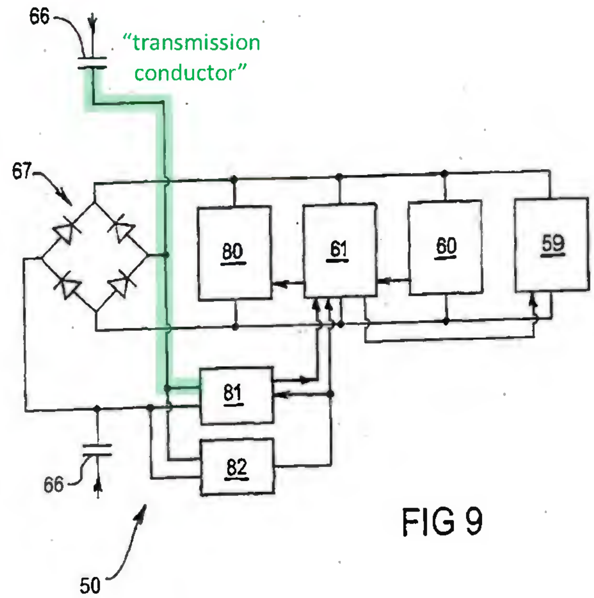

FIG 9

3. Claim 24

a) The method of claim 6, wherein the conductive substance includes a metallic material.

Birrell discloses this limitation for the reasons discussed above for claim 23 of Ground 1. (Section IX.A.15; Ex. 1002, ¶161.)

F. Ground 6: Claims 7, 8, and 25 Are Obvious Over *Birrell*, *Logan*, and *Camras*

1. Claim 7

a) An apparatus comprising:

To the extent limiting, *Birrell* discloses an "apparatus" for the reasons above for limitation 10(a) (tile 50 as "apparatus"). (Section IX.A.4(a); *infra* Sections IX.F.1(b)-(g); Ex. 1002, ¶¶162-163.)

b) an LED circuit including a plurality of LEDs;

Birrell discloses this limitation for the reasons above for limitation 10(b). (Section IX.A.4(b); Ex. 1002, ¶164.)

c) a data receiver, wherein the data receiver is configured to receive data from an antenna;

Birrell in view of *Logan* discloses/suggests this limitation for the reasons above for limitation 10(e). (Section IX.A.4(e); Ex. 1002, ¶165.)

d) a first circuit configured to detect contact with a conductive substance via capacitive sensing for at least controlling the LED circuit;

Birrell discloses this limitation for the reasons above for limitations 1(c)(2), 10(d). (*Supra* Sections IX.A.1(c)(2), IX.A.4(d); Ex. 1002, ¶166.)

e) a second circuit having a transmission conductor and an inductor, wherein the second circuit is configured to use at least the inductor to receive power wirelessly for powering the apparatus; and

Birrell in view of *Logan* discloses/suggests this limitation for the reasons above for limitations 1(b) and 1(c)(3) (modified tile 50 in *Birrell-Logan* combination includes a circuit having a transmission conductor and inductor like that in limitation 7(e).) (*Supra* Sections IX.A.1(b), IX.A.1(c)(3); Ex. 1002, ¶167.)

f) a lens doped with particles configured to transmit light,

The *Birrell-Logan* combination in view of *Camras* discloses/suggests this limitation. (Ex. 1002, ¶¶168-171.) *Birrell* discloses that a front cover of lighting tile 50 may be an optical lens (Ex. 1005, 16:27-36) and that certain coatings/layers may be applied to the LED to change its light color (*id.*, 12:4-21). While *Birrell* does not expressly disclose that the lens is "doped with particles configured to transmit light," a POSITA would have found it obvious to implement such features in view of *Camras*. (Ex. 1002, ¶168.)

Camras discloses an LED lighting device. (Ex. 1009, Abstract) and that "conventional phosphor particles" may be used to dope optical lenses of LEDs to "convert[]" light of wavelengths emitted…to other wavelengths." (Ex. 1009, ¶¶ [0054], [0059].) Indeed, *Camras* teaches doping the LED lens with particles (e.g., phosphor) to transmit lights of different colors, similar to as described in the '298 patent. (Ex. 1001, 14:13-19; Ex. 1002, ¶169.)

A POSITA when implementing *Birrell* (as modified above) would have been motivated to look to *Camras*, as both *Birrell* and *Camras* disclose applying phosphor

particles to an LED to change its color. (Ex. 1005, 12:4-21 (phosphor coating/layer may be directly applied on to LED or disposed at or adjacent to the first major surface of the lighting element); Ex. 1009, ¶¶[0054] ("phosphor particles"), [0059].) In light of such disclosures/suggestions, a POSITA would have been motivated to configure the LED lighting components of the modified tile 50 to include a lens doped with particles (e.g., phosphor particles) to transmit light to allow the *Birrell-Logan* apparatus to provide LED illumination at different colors. (Ex. 1002, ¶170.) A POSITA would have understood that using a doped lens with the LED components in *Birrell* would have been one of several predictable configuration options, given that (consistent with that known by a POSITA) the light emitted from *Birrell*'s LEDs would need to travel through a lens before being observed. (Ex. 1005, 16:27-36 (lens may provide "an optical correction for emitting light" or "other applied optical techniques").)

Thus, a POSITA would have had the skills/motivation (with a reasonable expectation of success) to implement the above modification, especially since the use of phosphor particles for modifying LED light color was well-known and available. (Ex. 1092, ¶[0195]; Ex. 1002, ¶171.) Likewise because such implementation would have involved applying known technologies and techniques (e.g., known phosphor coating techniques for LEDs (*Birrell* and *Camras*)) to yield

the predictable result of providing LEDs of different colors in the combined *Birrell-Logan* apparatus. (Ex. 1002, ¶171.) *See KSR*, 550 U.S. at 416.

g) wherein the apparatus is portable.

Birrell discloses this limitation for the reasons above for claim 17(e). (*Supra* Section IX.A.10(e); Ex. 1002, ¶172.)

2. Claim 8

a) The apparatus of claim 7, wherein said apparatus is configured to provide power to said LED circuit after detection of a touch.

Birrell discloses this limitation for the reasons above for claim limitations 10(b) and 14. (Sections IX.A.4(b) and IX.A.8; Ex. 1002, ¶173.)

3. Claim 25

a) The apparatus of claim 7, wherein the conductive substance includes a metallic material.

Birrell discloses this limitation for the reasons above for claim 23. (Section IX.A.15; Ex. 1002, ¶174.)

G. Ground 7: Claim 9 Is Obvious Over *Birrell*, *Logan*, and *Gleener*

1. Claim 9

a) An apparatus comprising:

To the extent limiting, *Birrell* discloses this preamble for the reasons above for limitation 10(a). (Section IX.A.4(a); *infra* Sections IX.G.1(b)-(f); Ex. 1002, ¶¶175-176.)

b) an LED circuit including at least one LED;

Birrell discloses this limitation for the reasons discussed above for limitation 10(b). (Section IX.A.4(b); Ex. 1002, ¶177.)

c) a data receiver, wherein the data receiver is configured to receive data from an antenna;

Birrell in view of *Logan* discloses this limitation for the reasons discussed for limitation 10(e). (Section IX.A.4(e); Ex. 1002, ¶178.)

d) a capacitor coupled to the antenna, wherein the capacitor is configured to tune the antenna; and

While the *Birrell-Logan* combination does not explicitly disclose a capacitor coupled to the disclosed antenna to tune the antenna (Section IX.A.4(e)), it would have been obvious to configure the *Birrell-Logan* combination to implement such features in view of *Gleener*. (Ex. 1002, ¶¶179-184.)

Birrell discloses that data communication between devices may be achieved using wireless techniques. (Ex. 1005, 8:4-30; *id.*, 8:31-9:10.) *Gleener* also discloses the use of antennas for wireless communication (Ex. 1010, Abstract, ¶[0002]), and thus a POSITA would have considered *Gleener* when implementing the *Birrell-Logan* combination. (Section IX.A.4(e); Ex. 1002, ¶180.)

Gleener discloses a known matching network 10 that includes a capacitor 18 coupled to an antenna 14 to "tune … the antenna" for transmitting wireless signals at a single prescribed frequency bandwidth. (Ex. 1010, ¶[0005].)

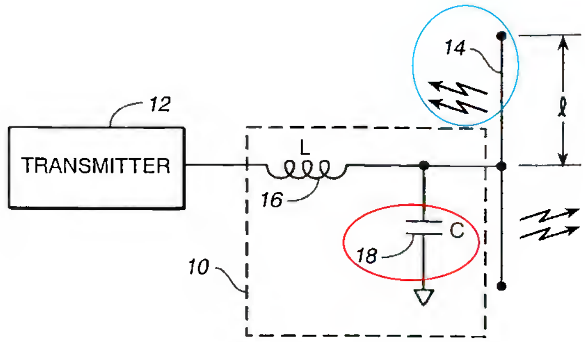

FIG._1
(PRIOR ART)

(Ex. 1010, FIG. 1 (annotated); Ex. 1002, ¶181.) *Gleener* also discloses a matching network 104 that includes a variable capacitor 108 coupled to antenna 106 "to tune the antenna system 100" for transmitting wireless signals at two separate frequency bandwidths. (*Id.*, ¶[0022]; *id.*, Abstract, ¶¶ [0013]-[0014], [0021], [0024]; Ex. 1002, ¶181.)

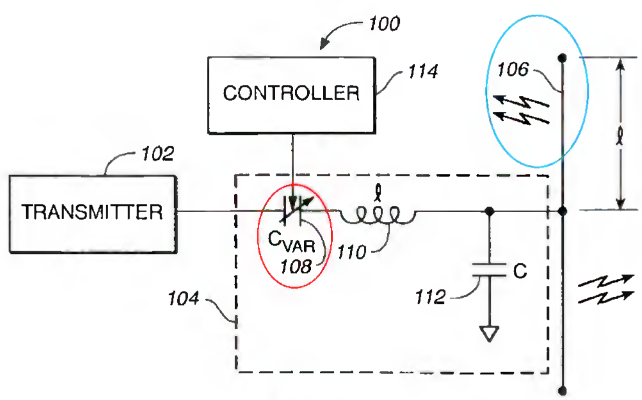

FIG._3

(*Id.*, FIG. 3 (annotated); *id.*, ¶¶[0021]-[0022]; Ex. 1002, ¶181.) A POSITA would have thus understood via *Gleener* that tuning an antenna by using a capacitor may

apply to both transmitters and receivers. (Ex. 1010, ¶¶[0012], [0020], [0022], [0025]-[0026]; Ex. 1002, ¶181.)

Thus, POSITA would have been motivated and found it predictable to configure the *Birrell-Logan* combination to couple a capacitor to the combined apparatus's antenna for tuning. (Ex. 1002, ¶182.) Indeed, as disclosed in *Gleener*, "[i]n order to assure the **maximum transfer of energy** …, the **impedances** between the antenna and the transmitter for the frequency of transmission **should be matched**." (Ex. 1010, ¶[0002].) Thus, a POSITA would have found it beneficial to use a matching network that includes a tuning capacitor, similar to as disclosed in *Gleener*, for transmitting or receiving wireless signals at one or more frequency bandwidths. (Ex. 1010, ¶[0020] ("transceiver 100 may also be a receiver or a transmitter depending upon the specific application"); ¶¶[0005], [0020]-[0022], FIGS. 1 and 3; Ex. 1002, ¶182.)

Such a configuration would have enabled the antenna in the *Birrell-Logan* apparatus to be precisely tuned to a frequency at which wireless transmissions occur, and also allowed it to be tuned to one of multiple frequencies, thus increasing the versatility and efficiency of the combined apparatus. (Ex. 1010, ¶¶[0011] ("enables…efficiently transmit[ting] signals"), [0014]; Ex. 1002, ¶183.)

A POSITA would have had a reasonable expectation of success implementing this feature, especially since such configurations were known in the art. (Ex. 1002,

¶184; Ex. 1016, 2:62-65 (tunable variable capacitor element), FIG. 5, 4:49-55 (capacitive tuning network 71 used with the antenna assembly 20); Abstract; Ex. 1026, 31-32 ("variable capacitor…for tuning a…receiver"); Ex. 1002, ¶184.) Indeed, *Gleener* discloses that the capacitor value in the matching network can be determined using "methods known in the art for impedance matching" (Ex. 1010, ¶[0025]) that may apply to "different type[s] of antenna structure" (*id.*, ¶[0027]). (Ex. 1002, ¶184.) Thus, the above configuration would have involved the use of known technologies/techniques (e.g., tuning capacitors for antennas) that would have led to the predictable result of providing tuning for the antenna in the *Birrell-Logan* apparatus. (Ex. 1002, ¶184.) *See KSR*, 550 U.S. at 416.

e) a transmission conductor configured to wirelessly receive an alternating electromagnetic field that is used to provide power to charge the apparatus,

Birrell in view of *Logan* discloses this limitation. (Ex. 1002, ¶¶185-186.) As discussed, an inductor and a conductive wire ("transmission conductor") in the *Birrell-Logan* apparatus receive the wirelessly transmitted power to power the LEDs. (Section IX.A.1(c)(3).) Such wireless power is transmitted/received in the form of an "alternating electromagnetic flux" ("alternating electromagnetic field"). (Ex. 1006, 3:19-5:4, 6:12-14 ("transmitted electromagnetic signal"), 7:20-26

("electromagnetic field transmitted by the transmission coil"); FIGS. 1-2; Ex. 1002, ¶185.)[18]

Additionally, *Birrell* discloses that tile 50 includes "energy storage components." (Ex. 1005, 15:34-16:10.) To the extent the "energy storage components" are found not to be chargeable, it would have been obvious to configure the energy storage components to be a rechargeable battery that is charged via the wirelessly received alternating electromagnetic field. (Ex. 1002, ¶186.) A POSITA would have recognized that choosing between a rechargeable and non-rechargeable battery would have been a choice between a finite number of predictable options, and that rechargeable batteries were known to be configured to wirelessly receive power. (Ex. 1002, ¶186; Ex. 1011, 3:23-34 (wirelessly received power "for charging a power storage device, such as batteries, in wireless and other electrical devices"); Ex. 1022, ¶¶[0085]-[0087] (rechargeable battery to power LEDs); Ex. 1002, ¶186.) Thus, implementing a rechargeable battery capable of being charged via the wireless signals provided in the *Birrell-Logan-Gleener* apparatus would have been obvious because it would have been one of a "finite

[18] PO asserts wireless charging "necessarily includ[es] a transmission conductor configured to wirelessly receive an alternating electromagnetic field." (Ex. 1110, 17; Ex. 1114, 15.)

number of identified, predictable solutions" for providing power to the apparatus. *Perfect Web Techs., Inc. v. InfoUSA, Inc.*, 587 F.3d 1324, 1331 (Fed. Cir. 2009). Recognizing the known benefits of rechargeable batteries, and the advantages of providing wireless charging of such components, a POSITA would have been motivated to implement such features in the *Birrell-Logan-Gleener* apparatus, and done so with a reasonable expectation of success, especially given the teachings/suggestions of *Birrell-Logan-Gleener* and state of the art knowledge. (Ex. 1002, ¶186.)

f) wherein the apparatus is portable.

Birrell discloses this limitation for the reasons above for claim limitation 17(e). (*Supra* Section IX.A.10(e); Ex. 1002, ¶187.)

H. Ground 8: Claim 16 Is Obvious Over *Birrell*, *Logan*, and *Rahmel*

1. Claim 16

a) An apparatus comprising:

To the extent limiting, *Birrell* discloses this preamble for the reasons for limitation 10(a) (Ground 1). (*Supra* Section IX.A.4(a) ; *infra* Sections IX.H.1(b)-(f); Ex. 1002, ¶¶188-189.)

b) an LED circuit comprising at least one LED;

Birrell discloses this limitation for the reasons discussed above for limitation 10(b) (Ground 1). (*Supra* Section IX.A.4(b); Ex. 1002, ¶190.)

c) a data receiver, wherein the data receiver is configured to receive data from a first antenna;

Birrell in view of *Logan* discloses/suggests this limitation for the reasons above for limitation 10(e) (Ground 1). (*Supra* Section IX.A.4(e); Ex. 1002, ¶191.)

d) a second antenna configured to receive radio frequency noise, wherein said radio frequency noise is used to provide power to said apparatus; and

Birrell in view of *Logan* and *Rahmel* discloses this limitation. (Ex. 1002, ¶¶192-197.) While the *Birrell-Logan* combination discloses "a first antenna," it does not expressly disclose "a second antenna" configured as claimed. Nevertheless, a POSITA would have found it obvious to implement this feature in view of *Rahmel*. (Ex. 1002, ¶192.)

Rahmel discloses a wireless power system, and thus a POSITA would have had reason to consider the teachings of *Rahmel* when implementing the *Birrell-Logan* apparatus (Ex. 1011, 1:7-13; Ex. 1002, ¶193.) *Rahmel* discloses using an energy reclamation system (ERS) antenna to receive ambient RF noise and convert the same to power a device and/or to charge a battery therein. (Ex. 1011, 1:52-2:20, FIG. 7.) Such ERS antenna may be implemented in addition to an existing antenna. (*Id.*, 9:56-10:15, FIGS. 6 and 11; Ex. 1002, ¶193.)

Rahmel explains that the separate antennas (ERS antenna and original antenna) can be "designed with different dimensions to receive signals at their respectively desired frequency bands." (Ex. 1011, 10:1-4; *id.*, 6:59-64, 9:56-10:15.)

Rahmel discloses that a design using multiple antennas allows efficient energy transfer. (*Id.*, 6:41-48 ("each antenna…can be designed to have maximum efficiency").) Furthermore, a dedicated ERS antenna could be placed in a location where the noise signal is strong in order to maximize energy collection. (*Id.*, 6:64-7:4; Ex. 1002, ¶194.) *Rahmel* also explains that energy collected via an ERS antenna may be stored in an energy storage subsystem (ESS), such as a rechargeable battery, as backup power. (Ex. 1011, 3:14-42, 5:26-50, 9:48-11:8, FIGS. 7 and 11.) Thus, a POSITA would have found it beneficial to implement an ERS antenna ("second antenna") in the *Birrell-Logan* apparatus in light of such guidance. (Ex. 1002, ¶¶194-195.)

Such a modification would have allowed the *Birrell-Logan* apparatus to benefit from efficient wireless communications over various frequencies and dedicated functionalities to improve operations of the apparatus (e.g., use of antennas for receiving power/data over different frequencies, receiving power to charge/power certain components (e.g., energy storage components, other components), etc.). (Ex. 1002, ¶196.) A POSITA would have considered the design trade-offs of including multiple antennas in the apparatus with the advantages and improved efficiencies, as suggested by *Rahmel*. (Ex. 1002, ¶196.)

A POSITA would have the capability and reasonable expectation of success in implementing such a modification, given the guidance by *Rahmel*, which explains

implementations of an ERS antenna can be flexible based on "any physical size limitations," and "the technology available." (Ex. 1011, 2:37-42; Ex. 1002, ¶197.) Thus, a POSITA would have had the capabilities and motivation (with reasonable expectation of success) to implement such a modification, especially given it would have involved applying known technologies/techniques (e.g., as described by *Birrell-Logan* and *Rahmel*) to yield the predictable result of providing multiple antennas in the combined apparatus, while achieving the benefits of receiving/providing efficient wireless power based on RF noise to power the apparatus and device components (e.g., battery, components, etc.). (Ex. 1002, ¶197.) *See KSR*, 550 U.S. at 416.

e) a circuit configured to detect contact with a user via capacitive sensing for at least controlling the LED circuit,

Birrell discloses this limitation for the reasons above for limitations 1(c)(2) and 10(d) and that its capacitive touch sensor is capable of "human touch sensing" ("detect contact with a user"). (*Supra* Sections IX.A.1(c)(2) and IX.A.4(d); Ex. 1005, 16:18-26; Ex. 1002, ¶198.)

f) wherein said apparatus is portable.

Birrell discloses this limitation for the reasons above for claim limitation 17(e) of Ground 1. (*Supra* Section IX.A.10(e); Ex. 1002, ¶199.)

I. Ground 9: Claim 22 Is Obvious Over *Birrell*, *Logan*, and *Sontag*

1. Claim 22

a) A system comprising:

To the extent limiting, *Birrell* discloses this preamble for reasons above for limitations 1(a) and claim 21. (*Supra* Sections IX.A.1(a), IX.A.14; *infra* Sections IX.I.1(b)-(d); Ex. 1002, ¶¶200-201.)

b) a transmit device, wherein the transmit device is configured to transmit power and signals; and

Birrell in view of *Logan* discloses this limitation for reasons above for limitations 1(b) and claim 4. For example, the *Birrell-Logan* combination discloses that a device (including, e.g., 48V AC supply and a transmitting coil) transmits both power and signals/data ("a transmit device"). (*Supra* Sections IX.A.1(b), IX.A.3; Ex. 1005, 8:31-9:10-29, 13:15-23, 23:15-21; Ex. 1002, ¶202.)

c) a data communications device, wherein the data communications device includes (a) at least one LED, (b) at least one antenna, and (c) at least one data communications circuit,

Birrell in view of *Logan* discloses this limitation. (Ex. 1002, ¶203.) The analysis for limitation 21(b) explains how the *Birrell-Logan* combination discloses a modified lighting tile 50 (a part of a lighting system and a "data communication device" of limitation 22(c)) that includes LEDs 59 ("at least one LED"), a receiving coil ("at least one antenna"), and a "data communications circuit," like that recited in limitation 22(c). (*Supra* Section IX.A.14(b); Ex. 1002, ¶203.)

d) wherein the transmit device is configured to transmit power and signals wirelessly to the data communications device using resonance and inductance.

Birrell in view of *Logan* and *Sontag* discloses this limitation. (Ex. 1002, ¶¶204-207.) As discussed for limitation 1(b) and claim 4, the device in the *Birrell-Logan* combination includes a power supply and transmits power and data ("transmit device" transmitting "power and signals") wirelessly to lighting tile 50 ("data communications device") based on inductive coupling via a transmitting coil ("using … inductance"). (*Supra* Sections IX.A.1(b) and IX.A.3; Ex. 1002, ¶204.) While the *Birrell-Logan* combination does not expressly disclose doing so using both "**resonance** and inductance," a POSITA would have found it obvious to implement such features in view of *Sontag*. (Ex. 1002, ¶204.)

Sontag discloses a wireless transmission system that may be used to transmit signal and electrical energy across a barrier, and thus a POSITA would have considered *Sontag*'s teachings/suggestions in light of *Birrell-Logan*. (Ex. 1012, 1:8-12, 1:29-33, 5:56-6:23; Ex. 1002, ¶205.) Indeed, *Sontag* discloses a system with a "transmitting antenna [that] consists of a **resonant LC circuit** involving **inductor** 22 and capacitor 24" and a "receiving antenna 20 also comprises an LC circuit consisting of inductor 26 and capacitor 28." (Ex. 1012, 3:2-13, FIGS. 1-3; *id.*, 3:14-4:21.) As such, *Sontag* discloses a wireless transmission system "using resonance and inductance" as claimed. (Ex. 1002, ¶205; Ex 1001, 24:57, 26:24-28.) Based on

the teachings/suggestions of *Birrell*, *Logan*, *Sontag*, and a POSITA's knowledge, a POSITA would have been motivated to modify the above-discussed *Birrell-Logan* "transmit device" (limitation 22(b)) to transmit power and signals wirelessly to the data communications device "using resonance and inductance." (Ex. 1002, ¶205.)

A POSITA would have been motivated to implement such a modification because, as guided by *Sontag*, it would have allowed the *Birrell-Logan* "transmit device" to have improved transfer characteristics relating to the receiving antenna of tile 50. (Ex. 1012, 2:12-19 (transfer characteristic…relatively independent of the distance," "radial misalignment," and "resonant frequency mismatch"); 2:31-34 (signal level at the receiver being "virtually constant over a much wider range of distance variations between the transmitting antenna and the receiving antenna, both axially and laterally"), 2:35-43, 4:50-5:48, FIGS. 4-5; Ex. 1002, ¶206.) A POSITA would have thus sought to achieve similar benefits in the *Birrell-Logan* system to allow wireless transmissions over a broader range of operating distances and thus expanding the implementation/applications of the system. (Ex. 1002, ¶206; Ex. 1012, 1:34-47, 3:7-14 (applications of other combinations to form a resonant circuit), 3:24-28; Ex. 1002, ¶206.)

A POSITA would have had the capability and motivation (with a reasonable expectation of success) to implement the above modification in light of teachings/suggestions of *Sontag* and *Birrell-Logan*, and that use of inductance and

resonance in electrical circuits were known in the art. (Ex. 1002, ¶207; Ex. 1013, 56 ("The most common LC [inductance-capacitance] circuits are resonant circuits"), 57-59.) Indeed, the modification would have involved applying known technologies and techniques (e.g., known wireless transmission features involving inductance and resonance (*Sontag*)) that would have led to the predictable result of a transmit device (as in the *Birrell-Logan* system) configured to wirelessly transmit power/signals using known resonance and inductance features, in a manner consistent with the operations of *Birrell*. (Ex. 1002, ¶207.) *See KSR*, 550 U.S. at 416.

X. DISCRETIONARY DENIAL IS NOT APPROPRIATE HERE

An evaluation of the factors under *Apple Inc. v. Fintiv, Inc.*, IPR2020-00019, Paper 11 (Mar. 20, 2020) (precedential), favors institution notwithstanding the concurrent Illinois Litigation (Section II).

The **first *Fintiv* factor** favors institution. Petitioner will seek a stay of the Illinois Litigation upon institution. At minimum, the Board should not speculate regarding the likelihood of stay, particularly because courts routinely issue stays after institution. *Western Digital Corp. et al v. Kuster*, IPR2020-01391, Paper 10 at 8-9 (PTAB Mar. 11, 2021; *Samsung Elec. Am., Inc. v. Snik LLC*, IPR2020-01427, Paper 10 at 10 (PTAB Mar. 9, 2021).

The **second and third *Fintiv* factors** also favor institution. The Illinois Litigation is at an early stage.[19] A trial date has not been set, and there has not been significant resource investment by the court and the parties, particularly compared to the resource expenditures leading up to a trial. (Exs. 1107, 1116.) Moreover, any trial (if it occurs) would likely only occur at least 102 weeks after the service of the complaint—and thus after a final written decision in this IPR. (Ex. 1108, 1-2 (document available at Northern District of Illinois website, estimating "Case Ready

[19] Although PO moved to transfer the Illinois Litigation to Texas, that motion was denied. (Ex. 1115.)

for Trial" 102 weeks after complaint served); Ex. 1107, 5 (Dkt. #16 showing summons returned May 19, 2021).)

The **fourth *Fintiv* factor** similarly favors institution. In the Illinois Litigation, PO has asserted claims 1, 3, 6–10, 12–19, and 21-22 of the '298 patent, while this Petition challenges all 25 claims, so the Illinois Litigation will not resolve all disputed validity issues. (Section IX; Ex. 1113, 2-5; Ex. 1114, 2-116.) Furthermore, Petitioner stipulates it will not pursue in the Illinois Litigation invalidity based on any instituted IPR grounds in this proceeding.

Finally, the **sixth *Fintiv* factor** favors institution. Petitioner diligently filed this Petition **within one week of PO's amended infringement contentions** in the Illinois Litigation (Ex. 1113), with strong unpatentability grounds. (Section IX.) Institution is consistent with the significant public interest against "leaving bad patents enforceable." *Thryv, Inc. v. Click-To-Call Techs., LP*, 140 S. Ct. 1367, 1374 (2020). Moreover, this Petition is the ***sole*** challenge to the '298 patent before the Board—a "crucial fact" favoring institution. *Google LLC v. Uniloc 2017 LLC*, IPR2020-00115, Paper 10 at 6 (May 12, 2020).

XI. CONCLUSION

Accordingly, Petitioner requests institution of IPR for the challenged claims based on the specified grounds.

Respectfully submitted,

Dated: September 7, 2021 By: /Joseph E. Palys/
Joseph E. Palys (Reg. No. 46,508)
Counsel for Petitioner

CERTIFICATE OF COMPLIANCE

Pursuant to 37 C.F.R. § 42.24(d), the undersigned certifies that the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 10,966,298 contains, as measured by the word-processing system used to prepare this paper, 13,907 words. This word count does not include the items excluded by 37 C.F.R. § 42.24 as not counting towards the word limit.

Respectfully submitted,

Dated: September 7, 2021 By: /Joseph E. Palys/
Joseph E. Palys (Reg. No. 46,508)
Counsel for Petitioner

CERTIFICATE OF SERVICE

I hereby certify that on September 7, 2021, I caused a true and correct copy of the foregoing Petition for *Inter Partes* Review of U.S. Patent No. 10,966,298 and supporting exhibits to be served via express mail on the Patent Owner at the following correspondence address of record as listed on PAIR:

K&L Gates LLP- Chicago
P.O. Box 1135
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By: /Joseph E. Palys/
Joseph E. Palys (Reg. No. 46,508)

Trials@uspto.gov
571-272-7822

Paper 5
Date: March 15, 2022

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO. LTD.,
Petitioner,

v.

LYNK LABS, INC.,
Patent Owner.

IPR2021-01347
Patent 10,966,298 B2

Before JON B. TORNQUIST, JENNIFER MEYER CHAGNON, and SCOTT RAEVSKY, *Administrative Patent Judges.*

TORNQUIST, *Administrative Patent Judge*.

DECISION
Granting Institution of *Inter Partes* Review
35 U.S.C. § 314

I. INTRODUCTION

A. Background and Summary

Samsung Electronics Co., Ltd. ("Petitioner") filed a Petition (Paper 1, "Pet.") requesting an *inter partes* review of claims 1–25 ("Challenged Claims") of U.S. Patent No. 10,966,298 B2 (Ex. 1001, "the '298 patent"). Lynk Labs, Inc. ("Patent Owner") did not file a Preliminary Response to the Petition.

We have authority to determine whether to institute an *inter partes* review. 35 U.S.C. § 314; 37 C.F.R. § 42.4(a)(2021). The standard for institution is set forth in 35 U.S.C. § 314(a), which provides that an *inter partes* review may not be instituted "unless the Director determines . . . there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition."

After considering the arguments and evidence of record, and for the reasons set forth below, Petitioner demonstrates a reasonable likelihood of prevailing with respect to the Challenged Claims of the '298 patent. Accordingly, we institute an *inter partes* review with respect to all challenged claims and grounds asserted in the Petition. *See SAS Inst. Inc. v. Iancu*, 138 S.Ct. 1348, 1355 (2018).

B. Real Parties-in-Interest

Petitioner identifies itself and Samsung Electronics America, Inc. as the real parties-in-interest. Pet. 1.

Patent Owner identifies itself as the real party-in-interest. Paper 4, 1.

C. Related Matters

The parties identify *Samsung Electronics Co. v. Lynk Labs, Inc.*, No. 1:21-cv-02665 (N.D. Ill.) as a related matter. Pet. 1; Paper 4, 1.

D. The '298 Patent

The '298 patent is directed to "alternating current ('AC') driven LEDs, LED circuits and AC drive circuits and methods." Ex. 1001, 1:65–67. The '298 patent explains that "LEDs are intrinsically DC devices that only pass current in one polarity and historically have been driven by DC voltage sources." *Id.* at 2:4–6. "With proper design considerations," however, the '298 patent reports that "LEDs may be driven more efficiently with AC than with DC drive schemes." *Id.* at 2:11–12.

In one aspect of the invention, a lighting system is provided having one or more LED circuits, with each LED circuit having at least two diodes connected to each other in opposing parallel relation. *Id.* at 4:30–34. The diodes of the '298 patent may include "any type of diode capable of allowing current to pass in a single direction, including but not limited to, a standard diode, a schottky diode, a zener diode, and a current limiting diode." *Id.* at 4:34–38.

Figure 37 is reproduced below:

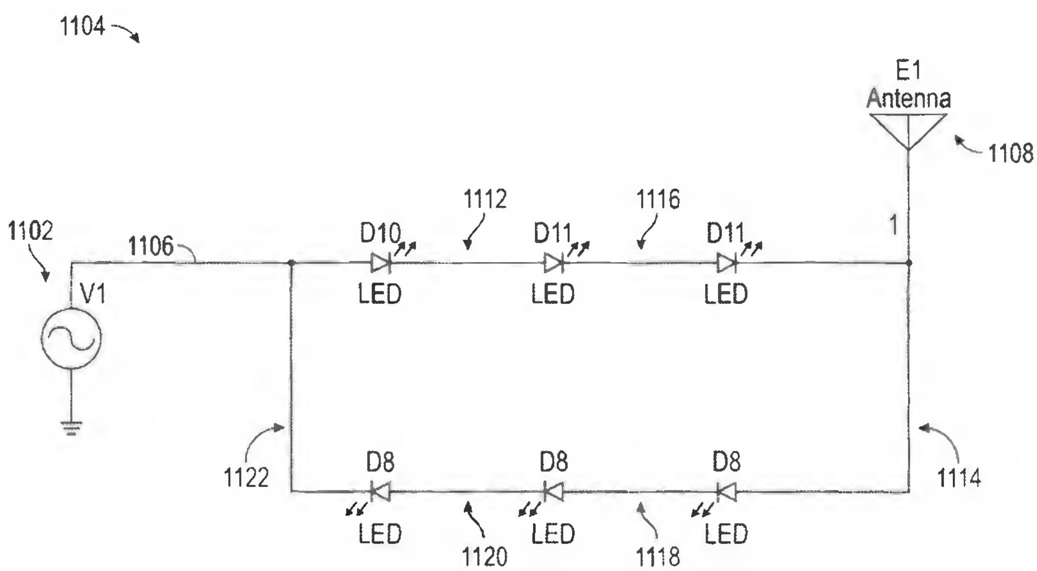

Figure 37 is a schematic view of a preferred embodiment of the ’298 patent and shows circuit 1104. *Id.* at 12:30–31, 20:16–17. As show in in Figure 37, in circuit 1104 “an alternating electric field is provided to a first transmission conductor by a signal generator 1102 and a second transmission conductor is provided by an antenna 1108.” *Id.* at 20:17–20. The ’298 patent explains that side 1112 of the directional circuit show in Figure 37 is “relatively more positive,” and sides 1114–1122 are “relatively less positive.” *Id.* at 20:22–25.

The ’298 patent explains that proximity may be sensed using impedance changes within the directional circuit caused by “approaching any of the directional circuits or transmission conductors” with a conductive substance, such as a person or metallic material, “thereby changing the circulation of current flow within the directional circuit by changes in impedance through the capacitance of the conductive substance.” *Id.* at 20:25–36.

E. Illustrative Claim

Petitioner challenges claims 1–25 of the ’298 patent. Pet. 2–3. Claim 1, reproduced below, is illustrative of the challenged claims:

> 1. An apparatus comprising:
>
> a first device including a first circuit having a first transmission conductor and a first inductor, wherein said first circuit is configured to use at least the first inductor to transmit power from the first device wirelessly; and
>
> a second device including
>
> (a) at least one LED,
>
> (b) a second circuit configured to detect contact with a conductive substance via capacitive sensing for controlling the at least one LED, and

> (c) a third circuit having a second transmission conductor and a second inductor, wherein said second device is configured to use at least the second inductor to receive power wirelessly from said first device for powering the apparatus.

Ex. 1001, 27:21–36.

F. Prior Art and Asserted Grounds

Petitioner asserts that claims 1–25 would have been unpatentable on the following grounds (Pet. 2–3):

Claim(s) Challenged	35 U.S.C. §[1]	Reference(s)/Basis
1, 3, 4, 10–15, 17–21, 23	103	Birrell[2], Logan[3]
2	103	Birrell, Logan, Johnson[4]
3, 10–12, 21	103	Birrell, Logan, Zhang[5]
5	103	Birrell, Logan, Sembhi[6]
6, 18, 24	102	Birrell
7, 8, 25	103	Birrell, Logan, Camras[7]
9	103	Birrell, Logan, Gleener[8]
16	103	Birrell, Logan, Rahmel[9]

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[1] The Leahy-Smith America Invents Act ("AIA"), Pub. L. No. 112-29, 125 Stat. 284, 287–88 (2011), amended 35 U.S.C. §§ 102 and 103, effective March 16, 2013. Because the '298 patent claims priority to an application filed October 6, 2008, and because neither party argues otherwise, we apply the pre-AIA versions of §§ 102 and 103 in this Decision. *See* 35 U.S.C. § 100(i)(1)(B).
[2] AU Application No. 2003100206, published July 17, 2003. Ex. 1005 ("Birrell").
[3] GB 2 202 414 A, published September 21, 1988. Ex. 1006 ("Logan").
[4] US 5,028,859, issued July 2, 1991. Ex. 1007 ("Johnson").
[5] US Patent Publication No. 2002/0021573 A1, published February 21, 2002. Ex. 1022 ("Zhang").
[6] US Patent Publication No. 2002/0060530 A1, published May 23, 2002. Ex. 1008 ("Sembhi").
[7] US Patent Publication No. 2002/0030194 A1, published March 14, 2002. Ex. 1009 ("Camras").
[8] US Patent Publication No. 2002/0175870 A1, published November 28, 2002. Ex. 1010 ("Gleener").
[9] US 6,882,128 B1, issued April 19, 2005. Ex. 1011 ("Rahmel").

Claim(s) Challenged	35 U.S.C. §[1]	Reference(s)/Basis
22	103	Birrell, Logan, Sontag[10]

In support of its grounds for unpatentability, Petitioner relies upon the declaration of R. Jacob Baker, Ph.D. Ex. 1002.

II. ANALYSIS

A. Claim Construction

In this proceeding, the claims of the '298 patent are construed "using the same claim construction standard that would be used to construe the claim in a civil action under 35 U.S.C. [§] 282(b)." 37 C.F.R. § 42.100(b). Under that standard, the words of a claim are generally given their "ordinary and customary meaning," which is the meaning the term would have had to a person of ordinary skill at the time of the invention, in the context of the entire patent including the specification. *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312–13 (Fed. Cir. 2005) (en banc).

Petitioner does not assert that any terms of the '298 patent require construction. And, upon review of the arguments and supporting evidence presented at this stage of the proceeding, we find that no claim terms require construction for purposes of this Decision. *See Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 868 F.3d 1013, 1017 (Fed. Cir. 2017) (quoting *Vivid Techs., Inc. v. Am. Sci. & Eng'g, Inc.*, 200 F.3d 795, 803 (Fed. Cir. 1999) ("[O]nly those terms need be construed that are in controversy, and only to the extent necessary to resolve the controversy.")).

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[10] US 4,654,880, issued March 31, 1987. Ex. 1012 ("Sontag").

B. Claims 1, 3, 4, 10–15, 17–21, and 23 over Birrell and Logan

Petitioner contends the subject matter of claims 1, 3, 4, 10–15, 17–21, and 23 would have been obvious over the combined disclosures of Birrell and Logan. Pet. 7–46.

1. Birrell

Birrell discloses "systems and methods for connecting electrical devices to power sources." Ex. 1005, 2:3–5. Figure 1 of Birrell is reproduced below:

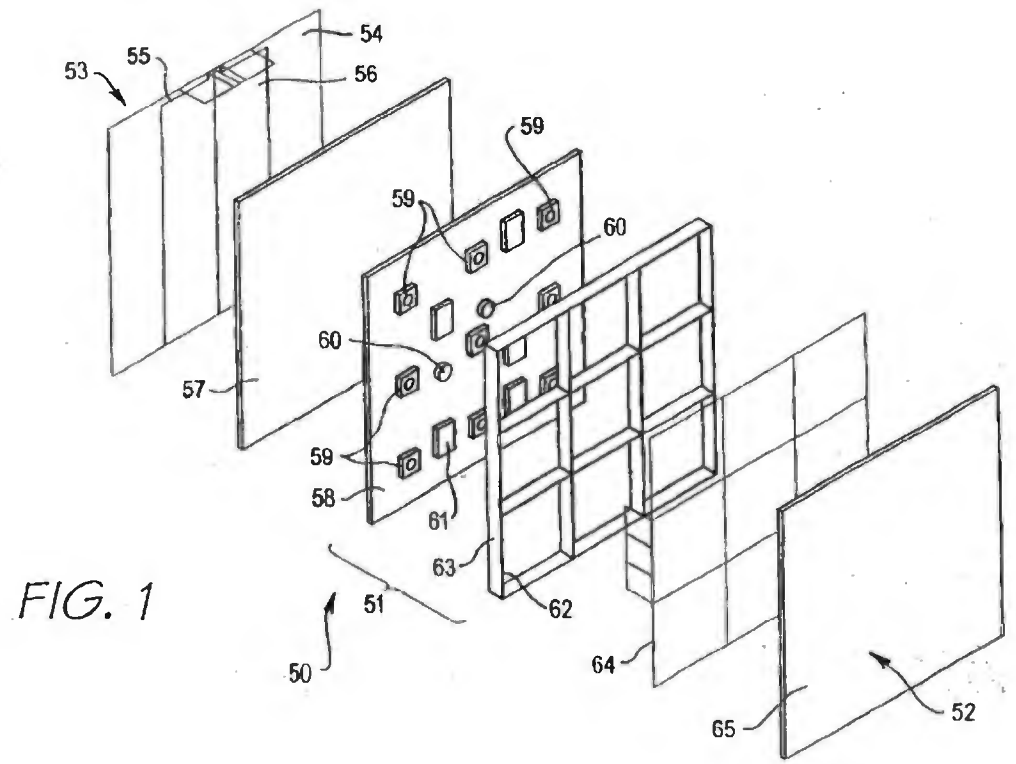


Figure 1 is an exploded view of a light tile for use in the lighting system of Birrell. *Id.* at 13:31–33. As shown in Figure 1, lighting tile 50 has "a thin body 51 having opposite first and second major surfaces" 52 and 53. *Id.* at 14:27–29. Back face 53 of body 51 includes metallized strips 55 and 56, which act as electrical coupling elements for tile 50 to "enable it to be

capacitively coupled to a power source." *Id.* at 14:31–37. Flexible magnetic sheet 57 provides an active magnetic force to secure the lighting tile to a magnetic receptive element. *Id.* at 15:5–8. Printed circuit board subassembly 58 supports LEDs 59 (which are set out in a 3 x 3 grid format), sensors 60, and microcontroller 61. *Id.* at 15:15–36. Circuit board 58 also supports power supply circuitry, such as bridge rectifiers and energy storage components, and data circuits that are used to modulate and demodulate signals. *Id.* at 16:6–10. Support frame 62 provides physical protection for the lighting components, and metallized polymer film 64 acts as a touch sensor to enable lighting tile 50 to be controlled, as least to some extent, by human touch on first major surface 52 of the tile body. *Id.* at 16:11–21.

Figure 8 of Birrell is reproduced below:

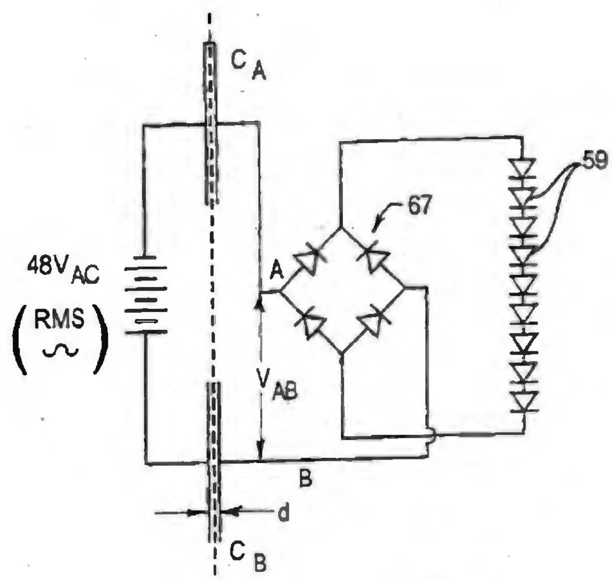


FIG 8

Figure 8 is a simplified circuit diagram of the lighting element of Birrell. *Id.* at 20:26–27. In the circuit depicted in Figure 8, a 48 Volt AC power supply is coupled to capacitors C_A and C_B and used to power LEDs 59. *Id.* at

21:15–34. Diodes 67 are configured to form a bridge rectifier, ensuring "that light is emitted from the LEDs during both the positive and negative cycles of the AC power supply." *Id.* at 19:1–7.

2. *Logan*

Logan discloses methods of "transmitting power and/or data through a solid member, such as an instrument panel or bulkhead." Ex. 1006, 1:3–5. Figure 2 of Logan is reproduced below:

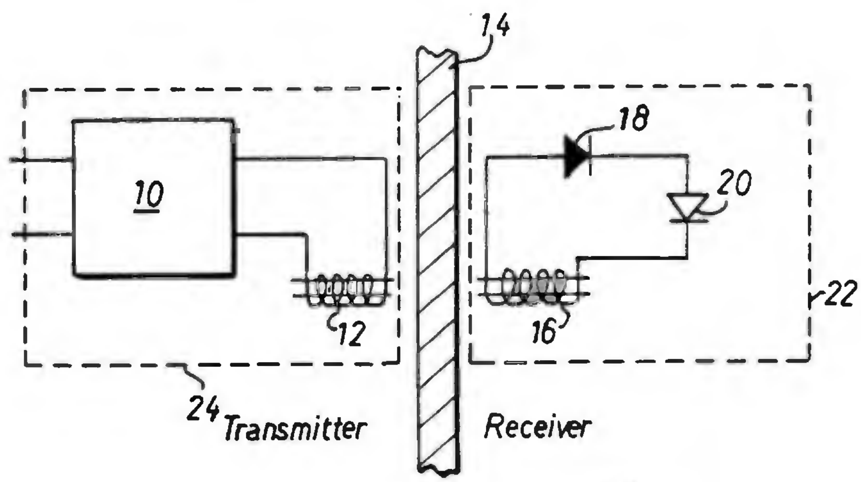


Fig 2

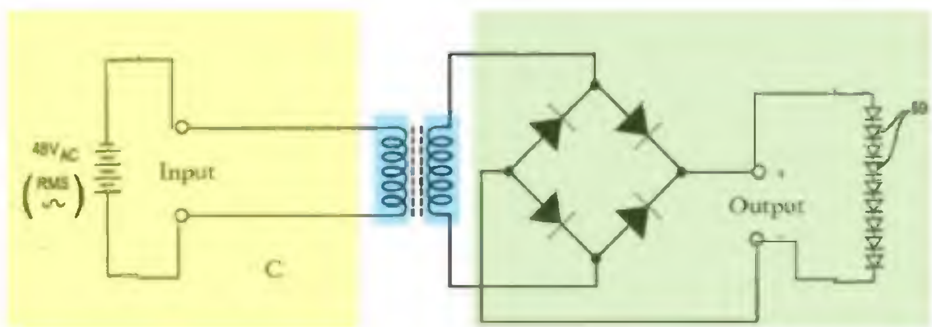
Figure 2 is a circuit diagram of an arrangement for transmitting power through a panel. *Id.* at 3:9–11. In Figure 2, oscillator 10 energizes transmitter coil 12 to create an alternating electromagnetic flux that penetrates through panel/bulkhead 14 and induces an electromagnetic force in receiver coil 16. *Id.* at 3:19–23. Diode 18 is connected in series with receiver coil 16 and LED 20, and power from receiver 16 is used to power LED 20. *Id.* at 4:12–14. According to Logan, elements 16, 18, and 20 may be encapsulated to form unitary component 22. *Id.* at 4:12–16.

3. Analysis: Independent Claim 1

Petitioner contends Birrell and Logan teach or suggest every limitation of independent claim 1. Pet. 7–22.

a) Combination of Birrell and Logan

Petitioner asserts that one of ordinary skill in the art would have combined the disclosures of Birrell and Logan in order to wirelessly transmit power using inductive coupling. Pet. 10–13. Petitioner contends the resulting apparatus would have the following configuration shown in Demonstrative A, below:



Demonstrative A

Demonstrative A, above, is Petitioner's depiction of the combination of portions of the circuit depicted in Figure 8 of Birrell and portions of the circuit depicted in Figure 2 of Logan. *Id.* at 17. In particular, in the combined apparatus of Birrell and Logan, capacitors C_A and C_B of Birrell are replaced by the transmitter coil and receiver coil of Logan, with the transmitter coil connected to the 48V AC input of Birrell via a transmission conductor and the receiver coil connected to the bridge rectifier of Birrell via a transmission conductor, which is in turn connected to LEDs 59.

According to Petitioner, the power supply, transmission conductor, and transmitter coil constitute a "first device," and the receiving coil, transmission conductor, bridge rectifier, and LEDs constitute a "second device." *Id.* at 18, 20. Petitioner also asserts that the transmission conductor extending from the power supply of the "first device" is a "first circuit," the capacitive touch sensor of Birrell (not shown in Demonstrative A) is a "second circuit," and the receiving coil and second transmission conductor of the "second device" constitute a "third circuit." *Id.* at 18–21.

Petitioner contends one of ordinary skill in the art would have sought to modify Birrell to use Logan's method of transferring power using inductive coupling because this method would avoid interference problems and would allow "flexibility" when wirelessly powering devices having different voltage requirements. *Id.* at 13–14 (explaining that voltage magnitude adjustments may be made by adjusting the windings of the coils; for example, by including more windings in the transmitting coil than the receiving coil the transmitted voltage may be reduced).

On this record, Petitioner explains sufficiently for purposes of institution why one of ordinary skill in the art would have combined the disclosures of Birrell and Logan to arrive at the devices and circuits set forth in Demonstrative A, and as described by Petitioner.

b) *An apparatus comprising: a first device including a first circuit having a first transmission conductor and a first inductor, wherein said first circuit is configured to use at least the first inductor to transmit power from the first device wirelessly; and*

Petitioner contends that the two devices set forth in Demonstrative A constitute an "apparatus," in the circuit depicted in Figure 8 of Birrell the

conductors that lead from the power source constitute "a first transmission conductor," and the transmitter coil of Logan is "a first inductor" that wirelessly transmits power via inductive coupling. Pet. 10–13.

On this record, we determine that Petitioner sufficiently explains for purposes of institution where Birrell and Logan, in combination, teach or suggest the "apparatus," "first device" and "first circuit" limitations of claim 1.

> *c) a second device including at least one LED and a second circuit configured to detect contact with a conductive substance via capacitive sensing for controlling the at least one LED*

Petitioner contends lighting tile 50 of Birrell contains "at least one LED," as well as a circuit configured to detect contact with a conductive substance, such as human touch. Pet. 19 (citing Ex. 1005, 14:26–15:33, 16:18–26, Fig. 8; Ex. 1002 ¶¶ 81–84).

On this record, we determine that Petitioner sufficiently identifies for purposes of institution where Birrell and Logan, as combined by Petitioner, disclose the "second device" limitations of claim 1.

> *d) a third circuit having a second transmission conductor and a second inductor, wherein said second device is configured to use at least the second inductor to receive power wirelessly from said first device for powering the apparatus*

As noted above, Petitioner contends that the device of Birrell and Logan has a third circuit with a conductor ("second transmission conductor") that extends from the receiving coil ("second inductor") and receives power wirelessly from the "first device" in order to power LEDs 59. Pet. 20–21.

On this record, we determine that Petitioner sufficiently identifies for purposes of institution where Birrell and Logan, as combined by Petitioner, disclose the "third circuit" limitations of claim 1.

e) Conclusion with Respect to Claim 1

Upon review of Petitioner's arguments and supporting evidence, we determine that Petitioner sufficiently identifies where Birrell and Logan teach or suggest every limitation of independent claim 1. Petitioner also provides a sufficient explanation as to why one of ordinary skill in the art would have combined Birrell and Logan to arrive at the subject matter of claim 1 with a reasonable expectation of success. Accordingly, Petitioner demonstrates a reasonable likelihood that claim 1 would have been obvious over Birrell and Logan.

4. Claims 3, 4, 10–15, 17–21, and 23 over Birrell and Logan

Petitioner provides a detailed explanation as to where each limitation of claims 3, 4, 10–15, 17–21, and 23 is taught or suggested by Birrell and Logan. Pet. 22–46. In particular, Petitioner presents evidence that (1) power supplies connected to AC mains were well known in the art and commonly used to provide power to lighting fixtures (claims 3 and 12[11]) (*id.* at 22–23 (citing Ex. 1002 ¶ 87; Ex. 1013, 157; Ex. 1024, 1:9–28, 1:35–48, Fig. 1; Ex. 1025, 1:10–25, Fig. 1)); (2) both Birrell's and Logan's systems are able to provide data and power through electrical or inductive coupling (claim 4) (*id.* at 24–25 (citing Ex. 1005, 8:31–9:10; Ex. 1006, 3:24–28, 5:18–6:2)); (3) the receiving coil of Logan is an "antenna" that can receive

[11] Of the claims challenged in this ground, claims 1, 10, 13, 17, 18, and 21 are independent. In addressing claims 10, 13, 17, 18, and 21, we discuss only those claim limitations that appear to be materially different than those discussed above with respect to independent claim 1.

both power and data (claims 10 and 18) (*id.* at 30–31 (citing Ex. 1013, 110, 161–166; Ex. 1006, 3:19–5:4, Figs. 1–2)); (4) the system of Birrell and Logan is configured to detect contact via capacitive sensing (claim 11) (*id.* at 31); (5) the "tile" of Birrell is a "flat planar substrate upon which is mounted a plurality of LEDs" (claim 13) (*id.* at 32 (citing Ex. 1005, 15:18–21, Fig. 1)); (6) Birrell's touch sensor allows power to be provided to the LEDs after detecting contact with a conductive substance (claim 14) (*id.* at 33–34 (citing Ex. 1005, 8:4–7, 15:21–33, 16:18–26; Ex. 1002 ¶ 103)); (7) Birrell discloses using organic LEDs (claims 15 and 19) (*id.* at 34, 39 (citing Ex. 1005, 11:35–12:3; Ex. 1002 ¶ 104)); (8) the tile of Birrell is "portable," as it may be "removed from a supporting structure" or implemented as a piece of furniture, such as a table surface (claim 17) (*id.* at 35–36 (citing Ex. 1005, 4:24–32, 15:8–14)); (9) the device of Birrell contains a MODEM that is able to modulate and demodulate transmitted data (claim 20) (*id.* at 39–40 (citing Ex. 1005, 23:15–29)); (10) the second device in Birrell/Logan can transmit power and signals wirelessly to the first device (claim 21) (*id.* at 42–43 (reversing the mapping set forth for claim 4)); and (11) the conductive substance of Birrell may include a metallic material (claim 23) (*id.* at 43–45 (citing Ex. 1005, 16:18–26)).

Upon review of Petitioner's arguments and supporting evidence, we determine that Petitioner demonstrates a reasonable likelihood that claims 3, 4, 10–15, 17–21, and 23 would have been obvious over Birrell and Logan.

C. *Remaining Obviousness Grounds*

Petitioner contends claim 2 would have been obvious over Birrell, Logan, and Johnson; claims 3, 10–12, and 21 would have been obvious over Birrell, Logan, and Zhang; claim 5 would have been obvious over Birrell, Logan, and Sembhi; claims 7, 8, and 25 would have been obvious over

Birrell, Logan, and Camras; claim 9 would have been obvious over Birrell, Logan, and Gleener; claim 16 would have been obvious over Birrell, Logan, and Rahmel; and claim 22 would have been obvious over Birrell, Logan, and Sontag. Pet. 2–3.

As noted above, Patent Owner did not file a Preliminary Response to dispute any of Petitioner's arguments or evidence.

Upon review of Petitioner's arguments and supporting evidence, we determine that Petitioner demonstrates a reasonable likelihood that claims 2, 3, 5, 7–12, 16, 21, 22, and 25 would have been obvious over the prior art set forth in the Petition.

D. Anticipation of Claims 6, 18, and 24 by Birrell

Petitioner contends that claims 6, 18, and 24 are anticipated by Birrell. Pet. 58–61.

1. Claim 6

Claim 6 requires a method of operating an apparatus that comprises wirelessly receiving power in the apparatus, transmitting or receiving data signals wirelessly, detecting contact with a conductive substance via capacitive sensing, and increasing a level of power to an LED circuit in the apparatus after detection of the contact. Ex. 1001, 27:46–54.

Petitioner contends the apparatus of Birrell wirelessly receives power and data through capacitive coupling (capacitors C_A and C_B), the touch sensor in tile 50 of Birrell detects contact with a conductive substance via capacitive sensing, and the apparatus of Birrell provides power to the LEDs after detection of contact. Pet. 58–60.

On this record, Petitioner identifies sufficiently for purposes of institution where Birrell discloses every limitation of claim 6. Accordingly,

Petitioner demonstrates a reasonable likelihood that claim 6 is anticipated by Birrell.

2. Claim 18

Claim 18 requires an apparatus comprising a flat planar substrate upon which is mounted a plurality of LEDs, a transmission conductor configured to provide data and power to said apparatus, and a data receiver configured to receive data from the transmission conductor or an antenna and power from the transmission conductor. Ex. 1001, 28:59–67.

Petitioner contends Birrell's tile 50 is a flat planar substrate upon which LEDs are mounted, Birrell's apparatus contains a transmission conductor between, for example, capacitor C_A and the bridge rectifier, and Birrell's demodulator (depicted in Figure 9) is a "data receiver" that is configured to receive data and power from the transmission conductor. Pet. 60–61.

On this record, Petitioner identifies sufficiently for purposes of institution where Birrell discloses every limitation of claim 18. Accordingly, Petitioner demonstrates a reasonable likelihood that claim 18 is anticipated by Birrell.

3. Claim 24

Claim 24 depends from claim 6 and further requires "wherein the conductive substance includes a metallic material." Ex. 1001, 29:27–28.

Petitioner argues that Birrell's "metallised polymer film 64" is a "conductive substance" that acts as a touch sensor. Pet. 43, 61.

On this record, Petitioner identifies sufficiently for purposes of institution where Birrell discloses every limitation of claim 24. Accordingly, Petitioner demonstrates a reasonable likelihood that claim 24 is anticipated by Birrell.

III. CONCLUSION

For the reasons discussed above, Petitioner demonstrate a reasonable likelihood that it would prevail in showing that claims 1–25 of the '298 patent are unpatentable.

IV. ORDER

Accordingly, it is:

ORDERED that, pursuant to 35 U.S.C. § 314(a), an *inter partes* review of claims 1–25 of the '298 patent is instituted with respect to all grounds set forth in the Petition; and

FURTHER ORDERED that, pursuant to 35 U.S.C. § 314(c) and 37 C.F.R. § 42.4(b), *inter partes* review of the '298 patent shall commence on the date of this Decision, and notice is hereby given of the institution of trial.

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UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.
Petitioner,

v.

LYNK LABS, INC.,
Patent Owner.

Case IPR2021-01347
U.S. Patent No. 10,966,298

PATENT OWNER'S RESPONSE PURSUANT TO 37 C.F.R. § 42.120

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2003	Deposition Transcript of Dr. Jacob Baker
2004	Statutory Disclaimer, Claims 18-20 of ’298 Patent
2005	*Excerpts from* Gibilisco, The Illustrated Dictionary of Electronics, McGraw-Hill, 8th Ed., 2001.

I. INTRODUCTION

U.S. Patent No. 10,966,298 (the "'298 Patent") is directed towards LED lighting systems, including those driven using AC power. Ex. 1001 ['298 Patent], Title. The '298 Patent claims several variations on these LED lighting systems, including using wireless power to power the systems and touch capacitance to control the systems.

Petitioner, Samsung Electronics Co., LTD. ("Samsung" or "Petitioner"), has asserted nine grounds of alleged unpatentability of the '298 Patent. Pet., 2-3. Ground 5 is anticipation of claims 6, 18 and 24 by the Birrell reference. Each remaining ground alleges obviousness over a combination of Birrell and Logan for claims 1, 3, 4, 10-15, 17-21 and 23 (ground 1), along with tertiary references Johnson, Zhang, Sembhi, Camras, Gleener, Rahmel and Sontag for the remaining claims (ground 2-4 and 6-9). Patent Owner has disclaimed claims 18-20. Ex. 2004 [Statutory Disclaimer].

As discussed below, the proposed combination of Birrell and Logan fails to disclose a number of the limitations of the remaining claims of the '298 Patent, including limitations related to wireless power supplies and antennas. Further, a POSITA would not look to combine the Birrell and Logan references because the

problems Petitioner identifies in Logan are unique to Logan and inapplicable to Birrell. Many of the other secondary references have similar problems.

For the reasons set forth below, the Petition fails to demonstrate by a preponderance of the evidence that any of the claims of the ’298 Patent are unpatentable.

II. OVERVIEW OF THE ’298 PATENT AND THE STATE OF THE ART

A. Technical Background

The ’298 Patent relates to an AC light emitting diode and AC LED drive methods and apparatus. Ex. 1001 [’298 Patent], Title.

The ’298 Patent discloses a variety of LED apparatus with LED circuits, circuits for detecting contact with a conductive substance, data receivers, transmission conductors for receiving power wirelessly and by wire, and so on. The ’298 Patent has sixty-eight figures illustrating various circuits for LED devices. For example, Figure 37 (below) illustrates one embodiment with an antenna 1108 connected to transmission conductor 1. Ex. 1001 [’298 Patent], 20:16-36.

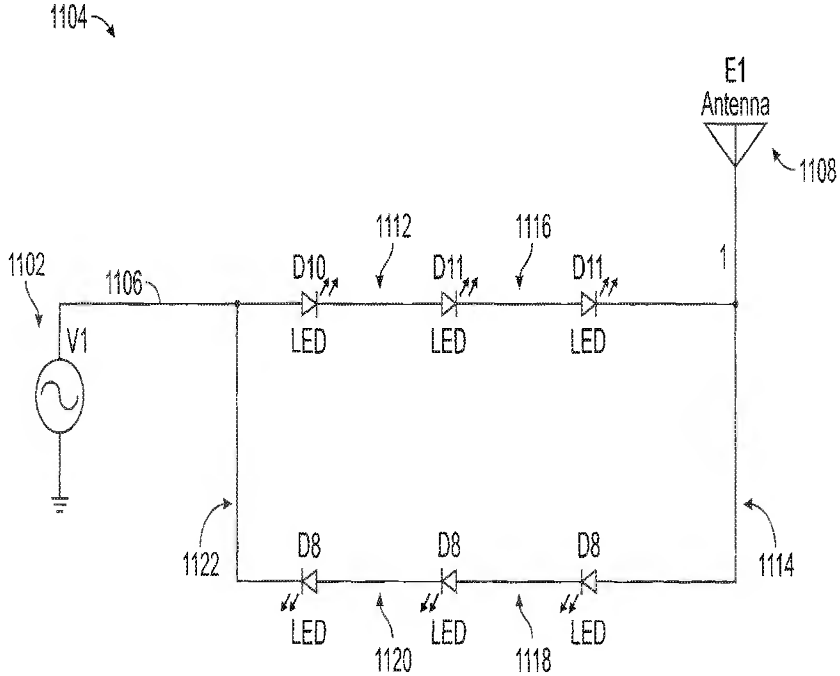


Figure 37 discloses a first transmission conductor coupled to a signal generator 1102 and a second transmission conductor coupled to an antenna 1108 (see FIG. 37): The '298 Patent explains as follows:

> FIGS. 37 and 38 discloses a circuit 1104 to illustrate another aspect of the invention. Accordingly, an alternating electric field is provided to a first transmission conductor by a signal generator 1102 and a second transmission conductor is provided by an antenna 1108 (see FIG. 37) or wire 1124 (see FIG. 38) that is connected to a relatively less positive side 1114-1122 within the directional circuit 1110. A

> difference in DC potential between a relatively more positive side 1112 within the directional circuit, and relatively less positive side 1114-1122 is provided.

Id., 20:16-35. The '298 Patent goes on to explain as follows:

> "Another aspect of the invention is sensing proximity with impedance changes within the directional circuits described herein (as it could be with any embodiment disclosed herein) by approaching any of the directional circuits or transmission conductors (also any of which are described herein), for example approaching 1108 (shown in FIG. 37) and/or 1124 (as shown in FIG. 38) with a conductive substance such as a person, including the touch of a person (human touch), or metallic material thereby changing the circulation of current flow within the directional circuit by changes in impedance through the capacitance of the conductive substance."

Ex. 1001 ['298 Patent], 20:25-36.

As another example, Figure 51 illustrates a transmission line 2062 carrying power and data received via wireless connection 2060 or wired connection 2061. Load 2066 could be a data receiver (as illustrated in Figure 53). "The circuit 2058 discloses the directional DC current flow as well as an AC plus DC current flow

and potential indicated by "AC+DC" in FIG. 51. This DC plus AC component is important to the transmission of information or data signals from the generators 2060, 2061." Ex. 1001 [298 Patent], 23:34-38. Figure 51 is shown below:

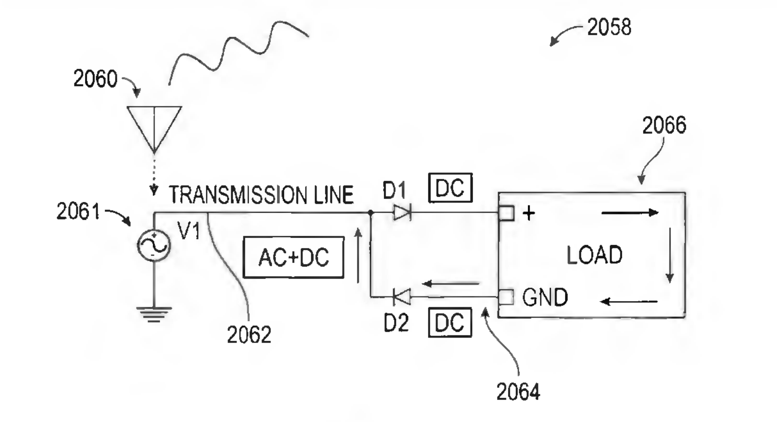


FIG. 51

Ex. 1001 ['298 Patent], Fig. 51.

According to another embodiment, FIG. 53 discloses another information or data communication circuit 2080. The circuit 2080 includes a signal generator 2082, a transmission conductor 2084, a directional circuit 2086, a data receiver 2088, and a ground switch 2090. *Id.*, 23:66-24:3. Figure 53 is illustrated below:

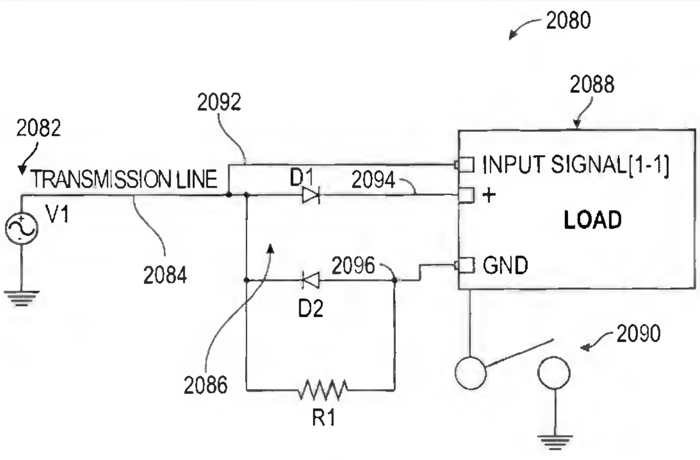


FIG. 53

Ex. 1001 ['298 Patent], Fig. 53.

According to another embodiment, Fig. 57 discloses another circuit 2126. The '298 Patent explains:

> Accordingly, an alternating electric field is provided to a transmission conductor 2132 by a signal generator 2128 that provides a first voltage level output equal to that provided by the signal generator 2128. A lump inductance 2130 is provided in series of the transmission conductor 2132 between the signal generator 2128 and directional circuit 2134. The lump inductance 2130 provides an increased voltage level from the relatively lower voltage on the transmission conductor 2132 at the point 2136 between the signal generator 2128 and lump inductance 2136 and a relatively higher

voltage level on the transmission conductor 2132 at the point 2138 between the lump inductance 2130 and the directional circuit 2134 thereby providing an increase in current flow within the directional circuit 2134 or electromagnetic field energy radiating from the circuit 2126. The amount of current flow within the directional circuits described herein and electromagnetic field energy external of the directional circuits described herein is dependent on the frequency of an AC signal provided to the transmission conductor 2132 (or any of which are described herein)."

Ex. 1001 ['298 Patent], 24:53-25:6. Fig. 57 is illustrated below.

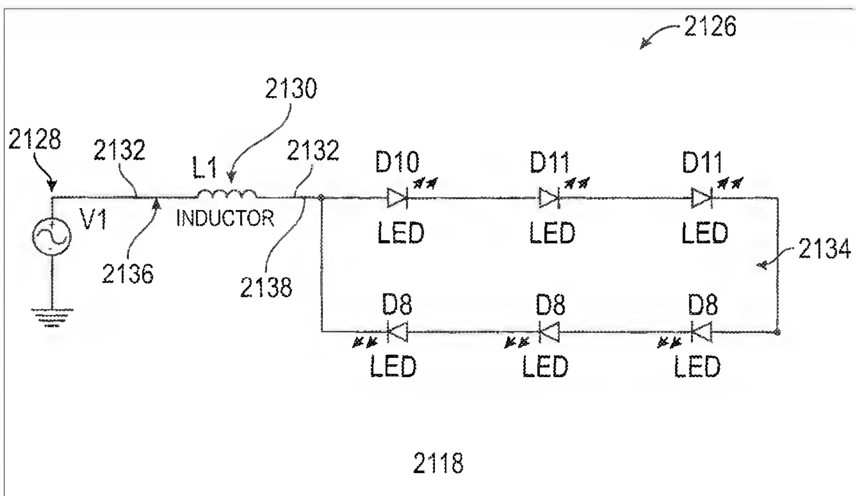


FIG. 57

Ex. 1001 ['298 Patent], Fig. 57.

In addition, claimed embodiments of the ’298 Patent include the ability to transmit power wirelessly (for example, through the use of inductors) (*see, e.g.,* claims 1, 6, 7, 9, 10, 21, 22), the use of AC power supplies (*see, e.g.,* claims 3 and 12), the use of capacitive sensing for controlling the lighting (*see, e.g.,* claims 1, 6, 7, 9, 11, 16, 21), and the use of an antenna to receive data (*see, e.g.,* claims 7, 9, 10, 13, 16, 17, 18, 21, 22).

B. Challenged Claims

The Petition has challenged each claim of the ’298 Patent. Claims 1, 6, 7, 9, 10, 13, 16, 17, 18 (disclaimed), 21 and 22 are independent. The remainder of the claims are dependent. In general, the claims of the ’298 Patent are directed toward novel variations on LED systems that utilize wireless power transfer and the use of capacitive sensing (e.g., touch capacitance) for input and control of the devices. The claims also incorporate concepts like wireless data transmission, the use of AC power inputs, and the doping of LED lenses.

C. Disclaimer

As noted at the outset, Patent Owner disclaimed former claims 18-20. Ex. 2004 [Statutory Disclaimer]. Patent Owner does **not** seek an adverse judgment as to these claims, does not concede that they are in the prior art, does not concede they are unpatentable, and disclaimed them to simplify the case. As discussed

below, the Board should not address the patentability of disclaimed claims 18-20, and instead should treat these claims as if they never existed.

The Federal Circuit has explained that "[d]isclaimed claims are treated as if they never existed, … and disclaimer does not legally constitute 'an admission that the subject of the disclaimer appears in the prior art,'" in the context of an *inter partes* review where, like here, the patent owner disclaimed a subset of the challenged claims after institution. *Raytheon Techs. Corp. v. Gen. Elec. Co.*, 993 F.3d 1374, 1379, n.4 (Fed. Cir. 2021).

The Board has recognized, consistent with *Raytheon*, that the Final Written Decision should not address disclaimed claims, and instead should treat disclaimed claims as if they never existed. *Axonics, Inc. v. Medtronic, Inc.*, IPR2020-00680, Paper 45, 4 (PTAB Sept. 22, 2021) ("We agree ... that we should not address the patentability of claims [disclaimed after institution] in this [Final Written] Decision. .... Rather, we treat [the disclaimed] claims ... as if they never existed.") (citing *Gunn v. Kopf*, 96 F.3d 1419, 1422 (Fed. Cir. 1996) and *Intel Corp. v. VLSI Tech. LLC*, IPR2018-01040, Paper 36, 16 (PTAB Feb. 12, 2020) ("Consistent with other Board decisions in which some, but not all, challenged claims have been disclaimed after institution, we address the patentability only of the remaining claims." (collecting decisions))); see also *Apple Inc. v. MPH Techs. Oy*, IPR2019-

00826, Paper 25, 10-11 (PTAB Nov. 4, 2020); *Apple Inc. v. INVT SPE LLC*, IPR2018-01473, Paper 27, n.1 (PTAB Mar. 25, 2020).

The Board has also confirmed that it "should not enter adverse judgment as to" claims disclaimed after institution when only a subset of the challenged claims has been disclaimed. *Intel Corp. v. VLSI Tech. LLC*, IPR2018-01040, Paper 36, 15-17 (PTAB Feb. 12, 2020). In *Intel*, the Board noted that "37 C.F.R. § 42.73(b)(2) permits disclaimer to be construed as a request for adverse action when there are '***no remaining claim[s] in the trial***.'" *Id.*

Similar to *Intel*, *Axonics*, and *Raytheon*, Patent Owner only disclaimed a subset of the challenged claims. As a result, the Board should not address the patentability of disclaimed claims 18-20, and instead should treat these claims as if they never existed.

D. Level of Ordinary Skill In The Art

Based on the technologies disclosed in the '298 Patent, a person of ordinary skill in the art ("POSITA") would mean someone who, at the time of the invention in February 2004, had at least a bachelor's degree in electrical engineering, computer engineering, computer science, physics, or the equivalent, and two or more years of experience with LED devices and related LED circuit design. Ex. 2001 [Credelle Dec.], ¶ 25.

The Petition alleges that a POSITA as of February 25, 2004 "would have had at least a bachelor's degree in electrical engineering, computer engineering, computer science, physics, or the equivalent, and two or more years of experience with LED devices and/or related circuit design, or a related field." Pet., 4. There are several problems with this definition. First, the definition contains an "and/or" qualifier that could be read as considering a person who has "related circuit design" experience but no experience with "LED devices" to be a POSITA. Additionally, the "or a related field" alternative is not appropriate because it may allow for a POSITA to be a person who has experience in an unspecified "related field" with no experience with LED devices. The Petition's definition could potentially apply to a person with no experience designing circuits and no exposure to LEDs. A POSITA should necessarily have experience with LED devices given that the field of the '298 Patent is LED lighting and the challenged claims pertain to apparatus with LEDs. Ex. 2001 [Credelle Dec.], ¶27.

III. CLAIM CONSTRUCTION

In accordance with 37 C.F.R. § 42.100(b), the PTAB construes the claims according to the same claim construction standard that would be used to construe the claims in district court. The claims should be construed starting with the ordinary and customary meaning as understood by the person of ordinary skill in

the art (POSITA) and considering the intrinsic evidence consisting of (1) the claim language, (2) the specification and (3) the prosecution history. *David Netzer Consulting Eng'r LLC v. Shell Oil Co.*, 824 F.3d 989, 993-94 (Fed. Cir. 2016); *Phillips v. AWH Corp.*, 415 F.3d 1303, 1312-15 (Fed. Cir. 2005).

Often, the specification is dispositive; it is the single best guide to the meaning of the disputed claim term and provides a "concordance for the claims." *Wright Medical Tech., Inc. v. Osteonics Corp.*, 122 F.3d 1440, 1443 (Fed. Cir. 1997); *Phillips v. AWH Corp.*, 415 F.3d 1303, 1315 (Fed. Cir. 2005). The specification acts as a dictionary when it expressly defines terms used in the claims or when it defines terms by implication. *Phillips*, 415 F.3d at 1321.

The Institution Decision preliminarily determined that no terms required construction. Paper 5, 6. For purposes of this response, Patent Owner proposes all claims be afforded their plain and ordinary meaning and does not propose any claim terms for express construction.

IV. GROUND 1: CLAIMS 1, 3, 4, 10-15, 17, 21 AND 23 ARE PATENTABLE OVER BIRRELL AND LOGAN

The objective standard for determining obviousness under 35 U.S.C. § 103, as set forth in *Graham v. John Deere Co.*, 383 U.S. 1 (1966), requires a factual determination to ascertain: (1) the scope and content of the prior art; (2) the level of ordinary skill in the art; and (3) the differences between the claimed subject

matter and the prior art. Based on these factual inquiries, it must then be determined, as a matter of law (4) whether or not the claimed subject matter as a whole would have been obvious to one of ordinary skill in the art at the time the alleged invention was made. *Id.* at 17.

A finding of obviousness requires a showing that as of the date of the invention (a) the prior art teaches or suggests each of the limitations of the claim; (b) there exists an apparent reason to combine and/or modify the prior art as proposed; and (c) a person of ordinary skill would have a reasonable expectation of success that the proposed combination and/or modification of the prior art would operate for its intended purpose. *See KSR Int'l Co. v. Teleflex Inc.*, 127 S. Ct. 1727, 1741 (2007); *Pfizer, Inc. v. Apotex, Inc.*, 480 F.3d 1348, 1361 (Fed. Cir. 2007); *Regents of Univ. of California v. Broad Institute, Inc.*, 903 F.3d 1286, 1291 (Fed. Cir. 2018).

Ground 1 of the Petition alleges that claims 1, 3, 4, 10-5, 17, 21 and 23 are obvious based on the combination of Birrell and Logan. Pet., 2. As discussed below, these claims are not rendered obvious based on Birrell and Logan.

A. Birrell (Ex. 1005)

Birrell (Ex. 1005) is Australian Patent No. 2003100206, filed on March 18, 2003 and published on July 17, 2003. Ex. 1005 [Birrell], 1. Birrell is titled

"Lighting system" and "relates generally to systems and methods for connecting electrical devices to power sources." Ex. 1005 [Birrell], 2:1-5. The purported invention of Birrell relates to "providing an improved system for connecting electrical devices to a power source." Ex. 1005 [Birrell], 2:29-31. In essence, Birrell is directed to an easy and safe way to attach and detach a lighting tile to a surface structure and provide power.

In the embodiment of Figure 1, Birrell discloses a "lighting tile 50 for use in a wide area lighting system 10." Ex. 1005 [Birrell], 14:26-27. Birrell describes the lighting tile 50 as having "a thin body 51" with a "layered structure made of six main components." Ex. 1005 [Birrell], 14:26-30.

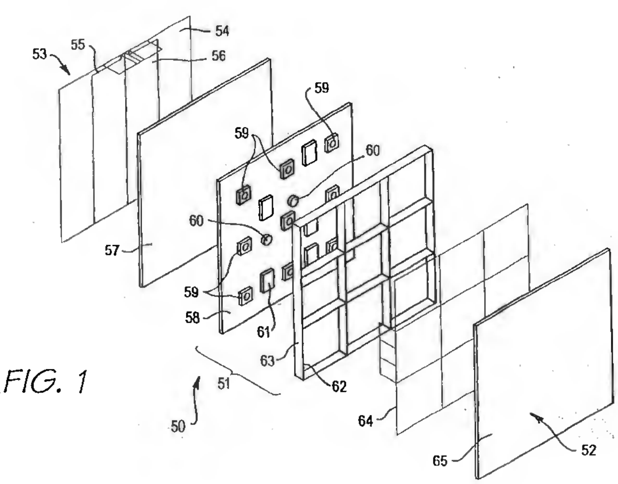


FIG. 1

The rear most component 54 includes "metallised strips 55, 56" which "act as electrical coupling elements for the tile 50 to enable it to be capacitively coupled

to a power source." Ex. 1005 [Birrell], 14:29-37. Behind metallized strips 55 and 56 is a magnetic sheet 57 that "provides an active magnetic force to secure the lighting tile to an appropriate magnetic receptive element." Ex. 1005 [Birrell], 15:5-8. LEDs 59 are mounted on circuit board 58. Ex. 1005 [Birrell], 15:15-21. Thus, the lighting tile is attached to a surface (such as a wall) and metalized strips 55 and 56 connect with similar strips (e.g., conductive elements 24 of Figs 2-3). on the surface to act as capacitors and form a circuit.

Birrell Fig. 8 is "a simplified circuit diagram of a lighting element including nine LEDs" that is "coupled to an AC power supply". Ex. 1005 [Birrell], 20:26-28.

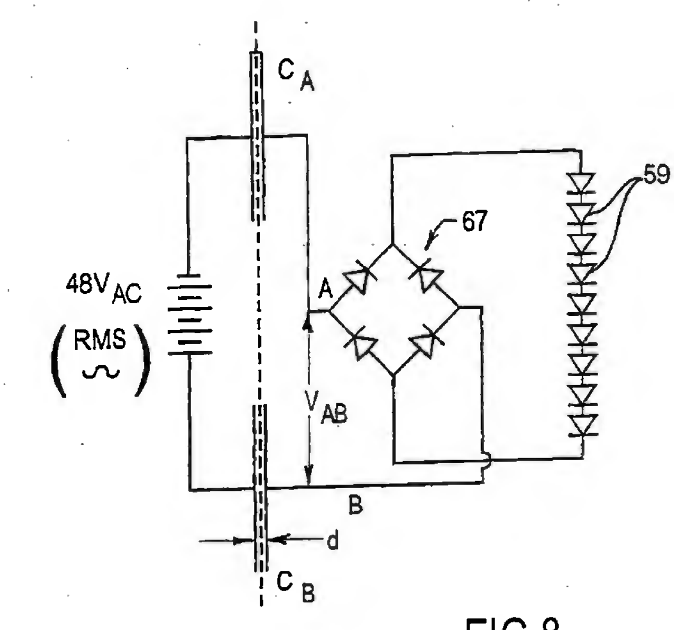


FIG 8

In Birrell Fig. 8, the capacitors are denoted by C_A and C_B. Capacitive strips 55 and 56 form the capacitor plates on the side of the lighting tile, and similar strips form the capacitor plates on the side of the 48V AC power supply. When attached (using magnets, as discussed above), the capacitive strips join to form a connection and complete the circuit.

B. Logan (Ex. 1006)

Logan (Ex. 1006) is UK Patent Application GB2202414A. Ex. 1006 [Logan], 1. Logan is directed to "transmission of power and/or data." Ex. 1006 [Logan], 1. Logan Fig. 2 (below) is a circuit diagram of one embodiment for transmitting power from oscillator 10 through panel/bulkhead 14 to power LED 20. Ex. 1006 [Logan], 3:9-11. "By arranging for the lamp unit to be fitted to the panel/bulkhead without penetrating right through it, the lamp unit can be powered and controlled from the transmission coil side of the panel/bulkhead without requiring any mechanical through-connection." Ex. 1006 [Logan], 2:27-3:2.

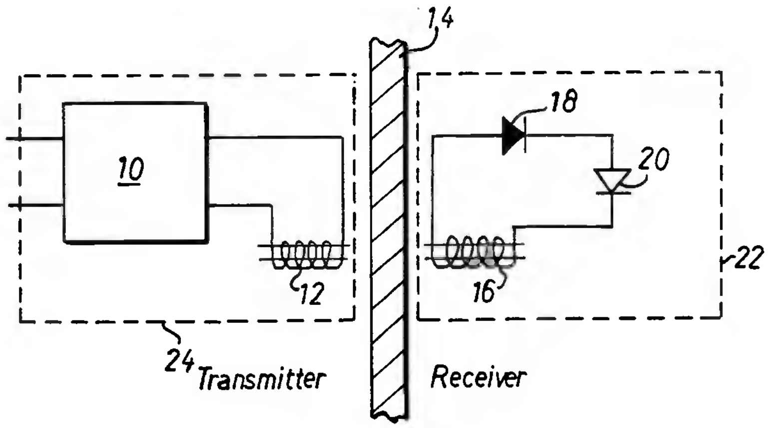


Fig 2

C. Claim 1 Is Patentable Over Birrell and Logan

The Petition alleges the combination of Birrell and Logan teaches claim 1. Pet., 7-21. Petitioner has failed to demonstrate that a POSITA would look to combine Birrell and Logan to arrive at the invention of claim 1.

1. The Petition Fails To Provide Sufficient Rationale For Combining Birrell With Logan

The Petition's rationales for combining Birrell and Logan fail. First, Petitioner argues that "a POSITA would have been motivated to modify *Birrell's* system to utilize inductive coupling to provide wireless power" because the "concentrated and localized nature" (Ex. 1006 [Logan], 6:3-11) of Logan's coils avoid alleged interference problems. Pet, 13. But nothing in Birrell or the '298 Patent indicates any interference issues with the systems disclosed therein. The interference issue in Logan is brought about because Logan is directed to situations

"where a number of transmissions are to be made in closely adjacent positions." Ex. 1006 [Logan], 1:12-17. The capacitors in Birrell are not acting as transmitters. Ex. 2001 [Credelle Decl], ¶ 76. Further, nothing in Birrell or the '298 Patent indicates a number of transmissions being made from closely adjacent positions. Thus, the problem Petitioner identifies is specific to Logan and not present in Birrell or the '298 Patent. Petitioner's rationale is hindsight. A POSITA would not be motivated to address this problem in Birrell because there is no reason to believe that interference issues exist in Birrell.

Petitioner further argues that "a POSITA would have appreciated that using inductive coupling to provide wireless power in Birrell would allow for voltage magnitude adjustments by adjusting the windings of the coils." Pet., 14. The Petition appears to suggest that Logan's coils can be used in a manner similar to a transformer for stepping voltage up or down. Logan does not teach using coils to adjust voltage magnitude. Ex. 2001 [Credelle Decl], ¶ 77. Instead, Logan teaches using coils to transmit a concentrated magnetic field through a barrier. *See* Ex. 1006 [Logan], 6:3-11. Using Logan's coils as a transformer would make this transmission more inefficient and would be contrary to the purpose of Logan. Ex. 2001 [Credelle Decl], ¶ 77. Further, Birrell teaches a system that is optimized to drive a string of LEDs with a 48VAC, safe power supply. Ex. 1005 [Birrell],

17:34-36. There is no need to step voltage down in Birrell. In fact, Petitioner's suggestion—providing a high voltage coil at the surface that Birrell's lighting tile 50 attaches to that would be stepped down in a coil in Birrell's modified lighting tile—could be dangerous and would be contrary to Birrell's goal of providing a safe system that does not present an electric shock hazard. Ex. 2001 [Credelle Decl], ¶ 77; Ex. 1005 [Birrell], 17:34-36.

The Petition argues that a POSITA would want to incorporate Logan's coils into Birrell in the manner suggested because Logan teaches that its system "can operate with a wide variety of panel/bulkhead materials" (Ex. 1006 [Logan], 4:1-5) and because "A POSITA would have appreciated that an inductively-coupled system/apparatus has improved transfer characteristics when properly configured." Pet., 14. But Petitioner gives no indication that incorporating Logan's coils into Birrell in place of Birrell's capacitors would improve Birrell's performance and does not explain how doing so "would have improved the flexibility in its design/implementation to accommodate different applications." Pet. 14. Further, the Petition does not explain, and it is not readily apparent, how the exhibits cited support Petitioner's point. Petitioner's argument is boilerplate without any concrete application to improving the system disclosed in Birrell.

Petitioner argues that "using inductive coupling (e.g., as in *Logan*) with Birrell would have been obvious because it would have been one of a finite number of identified, predicable solutions" for transmitting power wirelessly. Pet., 14-15 (citations and quotations omitted). But the Petition has not identified any problem where incorporating inductive coupling into Birrell would provide a solution. The goal of Birrell is not improved wireless power transmission, it is providing a safe, easily detachable LED lighting tile. *See* Birrell, 24:35-25:3.

Petitioner's implication that Birrell is directed toward wireless power transmission rests on Birrell's use of capacitors to connect its power supply to its LED lighting tile. But the use of capacitors in a circuit does not mean that the circuit is directed to wireless power transmission. Ex. 2001 [Credelle Decl],¶ 80. All capacitors have narrow spaces between their plates, but a POSITA would not understand the mere use of capacitors in a circuit to imply wireless power transmission. Ex. 2001 [Credelle Decl], ¶ 80.

Further, even if improved wireless power transmission were a goal in Birrell (which it is not), a POSITA would not look to inductive coupling as an identified, predictable solution. This is because, as discussed in the next section, incorporating Logan's inductive coupling would cause significant issues with the system of Birrell.

Petitioner has the burden of proving unpatentability by a preponderance of the evidence. 35 U.S.C. § 316(e). Petitioner's rationales for combining Birrell and Logan fail to carry this burden. Accordingly, the Board should confirm the patentability of claim 1.

2. A POSITA Would Not Look To Combine Birrell With Logan As Described In The Petition

A POSITA would not look to combine Birrell and Logan because of a number of problems arising from the combination. First, adding Logan's bulky inductive coils to the system of Birrell would result in a bulkier and thicker system than is desired in Birrell. Birrell discloses a lighting tile for use in general lighting applications that is thin, easily installed and moved, and that uses capacitive coupling of power from a power circuit to the lighting tile. Ex. 2001 [Credelle Decl.], ¶ 82. Fig. 1 of Birrell, below, illustrates Birrell's lighting tile 50.

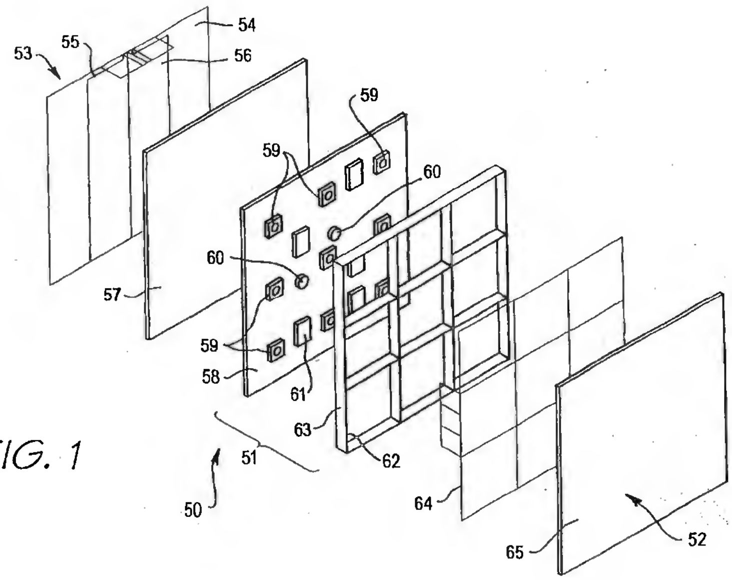


FIG. 1

The lighting tile is magnetically attachable to the surface through flexible magnetic sheet 57 and a metallized polymer film 64 that acts as a touch sensor. Ex. 1005 [Birrell], 15:5-14, 16:18-26. The capacitive coupling disclosed is "non-dissipative" and is designed for a lower degree of alignment accuracy compared to prior art lighting without capacitive coupling. Ex. 1005 [Birrell], 2:29-4:17, 6:9-21. One advantage of Birrell's lighting tile 50 is that it is "thin and generally planar" and "may be releasably affixed to a surface, such as a wall." Ex. 1005 [Birrell], 13:15-18. Thus, the point of Birrell is creating a convenient way to attach a lighting tile to a wall. While power in Birrell is transferred via capacitive coupling (Ex. 1005 [Birrell], 13:18-21), this is for convenience and safety in attaching the lighting tile to the wall, not a technique to more efficiently transfer

power wirelessly. Ex. 2001 [Credelle Decl.], ¶ 85. No inductors are disclosed or required in Birrell for wireless power transfer, and Birrell is not truly a wireless system. Birrell's capacitive plates only transfer power wirelessly in the sense that every capacitor transfers power wirelessly. Ex. 2001 [Credelle Decl.], ¶ 85. *See* Birrell Fig. 8 (annotated) below.

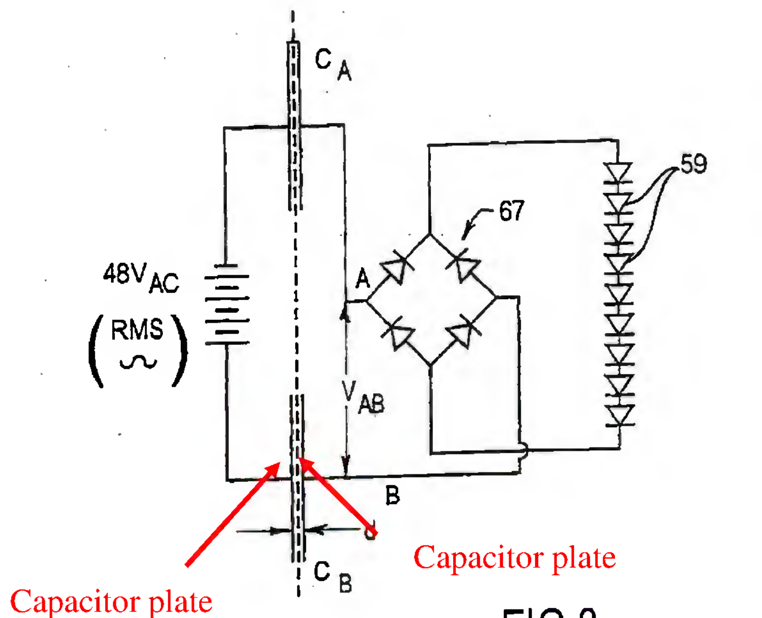


FIG 8

Logan, on the other hand, teaches a system that uses iron-core coils aligned across a panel boundary to couple localized energy across the gap. Ex. 1006 [Logan], Abstract. The point of Logan is to provide a concentrated magnetic field that can transmit power through a barrier. Ex. 1006 [Logan], 2:7-9, 3:19-23, 6:3-

11. These coils are necessarily bulkier and heavier than the thin metal strips that comprise the coupling capacitors of Birrell. Ex. 2001 [Credelle Decl.], ¶ 87.

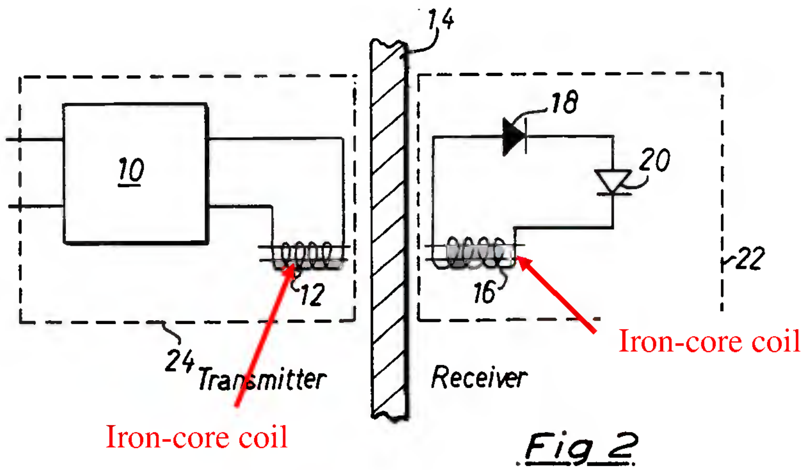


Fig 2

Unlike Birrell, where the purpose is to have a thin lighting tile that is easy and safe to attach and remove from a surface, Logan is not primarily concerned with how its lamp unit is attached. Ex. 1006 [Logan], 2:14-17 ("Such a lamp unit can be mounted on a panel/bulkhead by any convenient means, e.g., by adhesive or by the use of a blind, screw-threaded hole…"). Because of this, alignment and mechanical coupling of the lamp unit is not a concern in Logan as it is in Birrell. Ex. 2001 [Credelle Decl.], ¶ 88.

A POSITA would not look to Logan to incorporate inductive coupling into Birrell's lighting tile 50 because the use of inductive coupling would degrade the overall performance of Birrell's lighting tile by increasing thickness, providing worse alignment tolerances, and creating excessive heating. For example, a

POSITA would understand the iron-core coils used by Logan to "produce a concentrated magnetic field" would be significantly thicker than the thin metal strips that comprise the capacitors of Birrell. Ex. 2001 [Credelle Decl.], ¶ 89. This additional thickness would increase the size (thickness) and weight of Birrell's lighting tile 50, which is contrary to Birrell's goal of a thin and planar lighting tile. Ex. 1005 [Birrell], 13:15-18 ("A preferred form of the present invention provides a lighting system wherein a thin and generally planar lighting element may be releasably affixed to a surface."). *See* Ex. 2001 [Credelle Decl.],¶ 89.

Second, the use of inductor coils would require significantly more precision than the use of capacitive plates in Birrell. One goal of Birrell is to provide a lighting tile that is easy to attach and remove ("releasably affixed") from a surface and has placement flexibility. *See* Ex. 1005 [Birrell], 26:35-27:5 ("The lighting tile element 50 can then be affixed [ ] with a large degree of flexibility of location. … [and] without marking the energized surface…"). The capacitive strips taught in Birrell provide flexibility to a user in terms of placing the lighting tile slightly off center or out of position yet are still able to provide power to the tile element 50. Ex. 2001 [Credelle Decl.], ¶ 90. The coils of Logan require specific alignment in order to provide the "concentrated and localized" magnetic field that is a goal of Logan. Ex. 1006 [Logan], 6:3-11. Minor changes in the placement of the coils

relative to one another (as occurs with Birrell's capacitive strips) will result in much less efficiency. Ex. 2001 [Credelle Decl.], ¶ 90. Therefore, unlike Birrell, Logan's primary embodiments teach a lamp unit that is permanently affixed to the surface. Ex. 1006 [Logan], 2:14-17 ("Such a lamp unit can be mounted on a panel/bulkhead by any convenient means, e.g., by adhesive or by the use of a blind, screw-threaded hole in the panel/bulkhead.").

Third, Birrell uses magnets to attach lighting tile 50 to the surface structure. Ex. 1005 [Birrell], 6:34-7:2. A POSITA would understand that continuous magnetic sheets, such as those used in Birrell, would not be suitable between the two coils as they would block the magnetic field between coils and greatly reduce efficiency. Ex. 2001 [Credelle Decl.], ¶¶91-92. Therefore, other mounting methods are proposed by Logan. *See* Ex. 1006 [Logan], 2:14-17 ("Such a lamp unit can be mounted on a panel/bulkhead by any convenient means, e.g. by adhesive or by the use of a blind, screw-threaded hole in the panel/bulkhead."). Logan's coils would not operate with the magnetic sheet of Birrell and therefore a POSITA would not look to incorporate Logan's coils into Birrell. Ex. 2001 [Credelle Decl.], ¶¶ 91-92.

Fourth, coils inherently have resistance. Ex. 2001 [Credelle Decl.],¶ 93. The resistance present in Logan's coils would cause additional heat that increase power consumption and reduce reliability in Birrell's system. Ex. 2001 [Credelle Decl.], ¶

93. Thus, a POSITA would not look to incorporate Logan's coils into Birrell's lighting system.

D. Claim 3 Is Patentable Over Birrell and Logan

Claim 3 is directed to "the apparatus of claim 1, wherein said second device is adapted to receive power from a power supply connected to an AC mains." Ex. 1001 ['298 Patent], Claim 3. Birrell and Logan do not teach claim 3 at least for the reasons discussed above for claim 1.

Further, neither Birrell nor Logan teaches a second device that is adapted to receive power from a power supply connected to an AC mains. Fig. 8 of Birrell discloses a 48 V AC input at 80 kHz. Ex. 1005 [Birrell], Fig. 8, 22:13-30, 17:34-36.

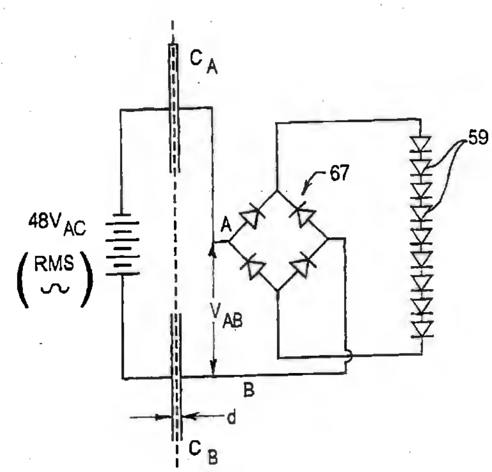


FIG 8

AC mains is understood to be the power received in a building, typically 110 V AC at 60 Hz in the United States. Ex. 2001 [Credelle Decl.], ¶ 98. 48 volts is a lower voltage and not an AC mains input. Ex. 2001 [Credelle Decl.], ¶ 98. Further, nothing in Birrell indicates that AC mains is connected to the 48 V AC power supply of Fig. 8. Ex. 2001 [Credelle Decl.], ¶ 98.

Similarly, Logan does not disclose a power supply connected to an AC mains. The power supply disclosed in Logan's Fig. 1 is "osullator 10" (sic). Ex. 1006 [Logan], 3:19-23.

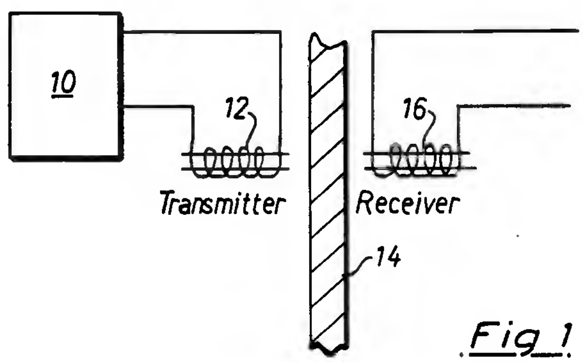


Fig 1

Logan does not disclose any other power supplies, or any AC Mains connected to oscillator 10. Ex. 2001 [Credelle Decl.], ¶ 100. Logan does not disclose anything about the voltage at oscillator 10, and describes the frequency as 200 Hz, which is not the typical AC mains frequency of 60 Hz. Ex. 1006 [Logan], 2:7-9, 8:1-4. Thus, neither Logan nor Birrell discloses a power supply connected to

an AC mains. *See also* Ex. 2003 [Baker Tr.], 83:3-14 ("Q. You agree that Birrell does not disclose AC mains, correct? A. … to answer your question, yes. Q. And Logan doesn't disclose AC mains either, correct? A. Not that I recall.").

The Petition concedes that Birrell "does not expressly disclose that the power supply is 'connected to an AC mains'" but argues that "it would have been obvious to implement such features in the Birrell-Logan modified apparatus." Pet., 22-23. Thus, neither Birrell nor Logan disclose this limitation and the Petition is instead relying on a POSITA's knowledge of the art. A POSITA's knowledge of the art should not be used to gap-fill missing limitations from the claim. *See DSS Tech. Mgmt. Inc. v. Apple Inc.,* 885 F.3d 1367, 1377 (Fed. Cir. 2018) (The Board may not "rel[y] on 'ordinary creativity' 'as a wholesale substitute for reasoned analysis and evidentiary support' 'when dealing with a limitation missing from the prior art references specified'") (*quoting Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355, 1361 (Fed. Cir. 2016)); *Nidec Motor Corp. v. Zhongshan Broad Ocean Motor Co.*, 851 F.3d 1270, 1274-1275 (Fed. Cir. 2017) (expert may not "fill in missing limitations" by alleging that a person of ordinary skill in the art would envision them). "In cases in which 'common sense' is used to supply a missing limitation, [the] search for a reasoned basis for resort to common sense must be

searching [particularly] where the missing limitation goes to the heart of an invention." *Arendi*, 822 F.3d at 1363.

Petitioner here is using a POSITA's alleged knowledge of the art to gap-fill a limitation that is missing from both Birrell and Logan. Thus, the Board must engage in the same "searching" inquiry laid out in *Arendi*. First, it must determine whether the limitation is "unusually simple and the technology particularly straightforward" or whether it "plays a major role in the subject matter claimed and affects much more than [the current limitation]" *Arendi*, 822 F.3d at 1362. Second, the Board must determine whether the gap-filling is supported with "reasoned analysis and evidentiary support." *Id.* at 1362.

The Petition makes no attempt to perform the searching inquiry required by *Arendi* and instead repeats typical rationales for combining under *KSR* as though the missing limitation were clearly disclosed in a prior art reference. Pet., 23-24. The Petition fails to identify, for example that the limitation is unusually simple and the technology particularly straightforward, or that the limitation does not play a major role in the subject matter claimed. Thus, the Petition has not met its burden to show that knowledge of a POSITA discloses this limitation.

Further, the system of Birrell would have to be redesigned to use AC mains. The power supply of Birrell is 48V AC power supply operating at very high

frequency to achieve high efficiency—80kHz—as shown in Birrell Fig. 8. Ex. 1005 [Birrell], 22:13-30. Birrell uses a 48V AC power supply so that they "system does not present an electric shock hazard to persons or animals." Ex. 1005 [Birrell], 17:34-36. Not only would AC mains require redesigning the system to use a different voltage and frequency (120V vs 48V and 60Hz vs 80 kHz), but it would also require using a higher voltage that could cause the electric shock hazard that Birrell is expressly designed to avoid. Ex. 2001 [Credelle Decl.], ¶ 101. Similarly, Logan teaches a 200Hz frequency for its oscillator that is different than AC mains. Ex. 1006 [Logan], 2:7-9, 8:1-4. A POSITA reviewing Birrell would not look to add AC mains to Birrell, or to the combination of Birrell and Logan proposed by Petitioner. Ex. 2001 [Credelle Decl.], ¶ 101.

Petitioner's suggestion that a POSITA, having already combined Birrell and Logan to arrive at a new device, would further add an additional undisclosed element into the proposed combination that requires further redesign of the existing combination is hindsight reasoning. Accordingly, the Board should reject Petitioner's argument.

E. Claim 4 Is Patentable Over Birrell and Logan

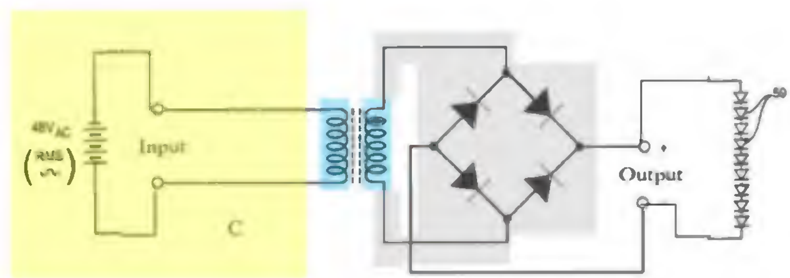
Claim 4 is dependent from claim 1. Claim 4 is therefore patentable over Birrell and Logan for at least the reasons identified above for claim 1.

F. Claim 10 Is Patentable Over Birrell and Logan

Claim 10 is an independent claim. Claim 10 is patentable over Birrell and Logan for the reasons identified in claim 1 related to combining Birrell and Logan. The proposed combination of Birrell and Logan also do not disclose or suggest the claimed power supply configured to receive power wirelessly from a power source. Further, the proposed combination of Birrell and Logan do not disclose or suggest a data receiver configured to receive data from an antenna.

1. Birrell and Logan do not disclose or suggest a power supply configured to receive power wirelessly from a power source

Birrell (and the combination of Birrell and Logan identified in Petitioner's demonstrative D, below) discloses a "48V AC power supply." The element in the yellow box is referred to in Birrell as a "48 Volt AC power supply." Ex. 1005 [Birrell], 17:25-28, 17:34-36. Birrell does not disclose a power source, or that the 48 Volt AC power supply receives power wirelessly from a power source.



Demonstrative D

Instead of identifying Birrell's "48V AC power supply" as the power supply in its combination of Birrell and Logan, Petitioner argues that a POSITA would understand the claimed power supply is "the rectifier (diodes 67) and conductors connecting the receiving coil". Pet., 28. The Petition relabels Birrell's "48V AC power supply" as a "48V AC power ***source***". Pet., 28-29. The Petition does not explain why a POSITA would consider a rectifier and conductor as the power supply rather than Birrell's "48V AC power supply" or why Birrell's "48V AC power supply" would be considered the claimed "power source" rather than the claimed "power supply."

A POSITA looking to the Petition's proposed combination of Birrell and Logan would not understand the bridge rectifier and conductor to be a power supply. Ex. 2001 [Credelle Decl.], ¶ 108. A rectifier simply converts alternating

current to direct current. Ex. 2001 [Credelle Decl.], ¶ 108. While a rectifier may be part of a power supply, it does not supply power and would not be considered a power supply. Ex. 2001 [Credelle Decl.], ¶ 108. Instead, a POSITA looking at the Petition's proposed combination of Birrell and Logan (as illustrated in Petitioner Demonstratives D and E) would understand Birrell's "48 Volt AC power supply" as the power supply. Ex. 2001 [Credelle Decl.], ¶ 108.

Alternately, the petition argues that "the rectifier (diodes 67), the receiving coil, and the conductors connecting the receiving coil in the modified tile 50 disclose the claimed 'power supply.'" Pet., 29. But the Petition does not explain how adding a coil to a rectifier creates a power supply, nor does it explain why Birrell's "48V AC power supply" does not, as Birrell clearly intended, constitute the power supply in the combination of Birrell and Logan proposed by Petitioner. Pet., 29.

Further, the relevant components the Petition identifies as a "power supply" are not operating as a power supply in Logan or Birrell. The purpose of the coil in Logan is not to regulate the power provided from the power supply by, for example, changing the voltage; instead, it is to transfer as much power as possible from the power supply. Ex. 1006 [Logan], 2:1-6 ("a system in which power or data is transmitted across a panel/bulkhead by means of a low frequency magnetic

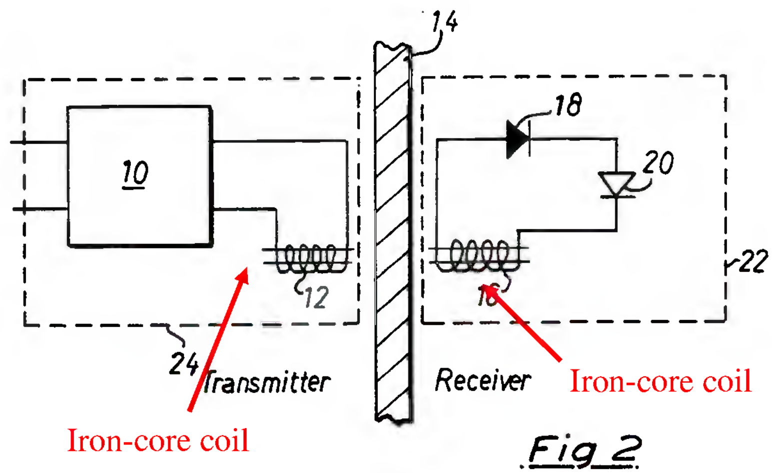
coupling between a pair of transmission and receiving coils…"). While Petitioner has changed the representation of Logan's coils to superficially represent the symbol for a transformer, nothing in Logan indicates its coils 12 and 16 were intended to be used to, for example, step voltage up or down. Ex. 2001 [Credelle Decl.], ¶ 110. Ex. 2003 [Baker Tr.], 74:14-24 ("the orientation of a component doesn't matter in the schematic, generally. … the physical implementation has nothing to do with the orientation on a schematic").

Similarly, the load in Birrell is calculated to use the 48V generated by Birrell's 48V AC power supply. Ex. 1005 [Birrell], 22:13-30 (discussing 48V voltage drop across capacitors and LEDs 59). If Birrell had intended other components—such as capacitive couplings 55 and 56 or diodes 67—to form a power supply, it did not identify them as such. Their purpose is simply to transfer the power from the 48V AC power supply to LEDs 59, not to act as a power supply themselves. Ex. 2001 [Credelle Decl.], ¶ 111.

Thus, Petitioner's proposed combination of Birrell and Logan does not disclose a power supply "configured to receive power wirelessly from a power source."

2. Birrell and Logan do not disclose or suggest a data receiver configured to receive data from an antenna

The Petition appears to rely on Logan as allegedly disclosing an antenna. The Petition argues that "a POSITA would have understood that [Logan's] receiving coil is an 'antenna'". Pet., 31. This is incorrect. Logan does not disclose an antenna, but teaches wireless transmission of power through two iron-core coils aligned across a gap.



Ex. 1006 [Logan], Fig. 2 (annotated).

A POSITA in 2004 would have understood a distinction between inductors that are part of a transformer and antennas. Ex. 2001 [Credelle Decl.], ¶ 115. In particular, a POSITA would understand that antennas convert incoming RF signals, such as radio waves, to AC currents. Ex. 2001 [Credelle Decl.], ¶ 115. The coils in Logan are not converting radio waves to AC current. Instead, they are

transferring energy using induction from one circuit to another. Ex. 2001 [Credelle Decl.], ¶ 115. Therefore, Logan's coils would not be considered as an antenna by a POSITA. Ex. 2001 [Credelle Decl.], ¶ 115.

This is consistent with the way "antenna" is used in the '298 Patent. For example, the antennas in Figs. 37 and 51 of the '298 Patent are used as described above—i.e., converting radio waves to AC current. Ex. 1001 ['298 Patent], Figs. 37, 51, 55, 20:17-22, 23:28-32, 24:31-37. These antennas are not being used for inductive coupling as the coils in Logan are.

Accordingly, Birrell in view of Logan does not disclose an antenna.

G. Claim 11 Is Patentable Over Birrell and Logan

Claim 11 is dependent from claim 10. Claim 11 is therefore patentable over Birrell and Logan for at least the reasons identified above for claim 10.

H. Claim 12 Is Patentable Over Birrell and Logan

Claim 12 is directed toward the apparatus of claim 10, "wherein said apparatus is configured to receive power from an AC mains power supply." Ex. 1001 ['298 Patent], Claim 12. Claim 12 is therefore patentable over Birrell and Logan for at least the reasons identified above for claim 10.

Further, for the same reasons described above for claim 3, neither Birrell nor Logan teaches an apparatus that is adapted to receive power from a power supply connected to an AC mains. *See* § IV.D, above.

I. Claim 13 Is Patentable Over Birrell and Logan

Claim 13 is an independent claim. Claim 13 is patentable over Birrell and Logan for the reasons discussed above for ground 1 claims 1 and 10. *See* §§ IV.C and F. In particular, neither Birrell nor Logan teaches the claimed antenna, and a POSITA would not look to combine Logan's coils into the capacitive coupling system of Birrell.

J. Claim 14 Is Patentable Over Birrell and Logan

Claim 14 is dependent from claim 13. Claim 14 is therefore patentable over Birrell and Logan for at least the reasons identified above for claim 13.

K. Claim 15 Is Patentable Over Birrell and Logan

Claim 15 is dependent from claim 13. Claim 15 is therefore patentable over Birrell and Logan for at least the reasons identified above for claim 13.

L. Claim 17 Is Patentable Over Birrell and Logan

Claim 17 is an independent claim. Claim 17 is patentable over Birrell and Logan for at least the reasons discussed above for ground 1 claims 1 and 10. *See* §§ IV.C, F. In particular, neither Birrell nor Logan teaches the claimed antenna, and a

POSITA would not look to combine Logan's coils into the capacitive coupling system of Birrell.

M. Claim 21 Is Patentable Over Birrell and Logan

Claim 21 is an independent claim. Claim 21 is patentable over Birrell and Logan for at least the reasons discussed above for ground 1 claims 1 and 10. *See* §§ IV.C and F. In particular, neither Birrell nor Logan teaches the claimed antenna, and a POSITA would not look to combine Logan's coils into the capacitive coupling system of Birrell.

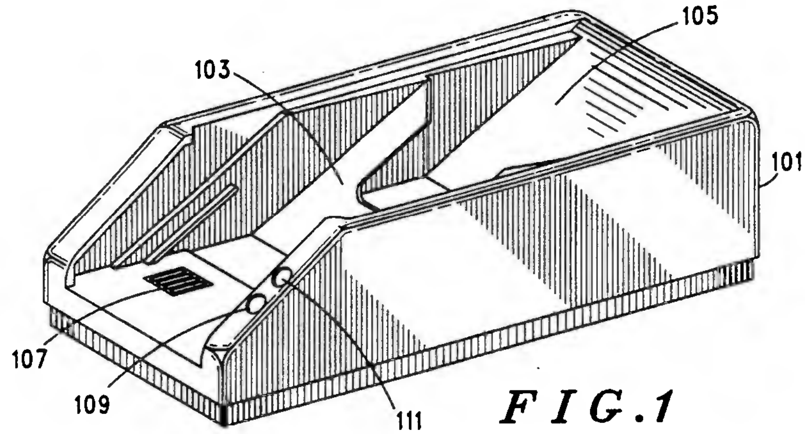
N. Claim 23 Is Patentable Over Birrell and Logan

Claim 23 is dependent from claim 1. Claim 23 is therefore patentable over Birrell and Logan for at least the reasons identified above for claim 1.

V. GROUND 2: CLAIM 2 IS PATENTABLE OVER BIRRELL, LOGAN AND JOHNSON

A. Johnson (Ex. 1007)

Johnson is directed to a multiple battery, multiple rate battery charger. Ex. 1007 [Johnson], Title. In particular, Johnson discloses a battery charger where "[t]wo or more batteries are charged sequentially in a multiple pocket battery chargers (sic) in order to maintain a low peak power consumption level." Ex. 1007 [Johnson], Abstract. Johnson Fig. 1 (below) illustrates the invention of Johnson in one embodiment.



F I G. 1

Johnson explains that "housing 101 contains the electronic circuitry, microprocessor, and software necessary to charge two batteries (not shown) in a predetermined sequence and with a priority of charge sequence such that both batteries are optimally charged without the power drain associated with charging both batteries simultaneously." Ex. 1007 [Johnson], 1:64-2:2. The only lighting discussed in Johnson is LED lights 109 and 111, which change from red to green depending on the charge status of the batteries. Otherwise, Johnson has nothing to do with LEDs or lighting.

B. Claim 2 Is Patentable Over Birrell, Logan and Johnson

Claim 2 claims the apparatus of claim 1, "wherein said first device comprises at least one colored LED." Claim 2 is therefore patentable over Birrell, Logan and Johnson for at least the reasons identified above for ground 1 claim 1.

In addition, Johnson is not analogous art to the '298 Patent and combining Johnson with the system of Birrell and Logan to arrive at the claimed invention of the '298 Patent would simply be hindsight reasoning. The test for determining whether art is analogous is "(1) whether the art is from the same field of endeavor, regardless of the problem addressed and, (2) if the reference is not within the field of the inventor's endeavor, whether the reference still is reasonably pertinent to the particular problem with which the inventor is involved." *In re Bigio*, 381 F.3d 1320, 1325 (Fed. Cir. 2004).

Johnson is directed to a battery charger. Ex. 1007 [Johnson], Title. The field of the '298 patent is LED lighting. Ex. 1001 ['298 Patent], Title. Nothing in '298 Patent claim 2 has anything to do with batteries and nothing in the '298 Patent has anything to do with battery charging. Ex. 2001 [Credelle Decl.], ¶ 136; Ex. 2003 [Baker Tr.], 25:4-18 ("I don't think all circuits in a battery charger would be related [to LED devices], but there could be some overlap.").

Further, Johnson is not reasonably pertinent to the invention of the '298 Patent. A POSITA looking to implement different colored LED lights in the invention of the '298 would not look to a reference directed toward charging batteries. Ex. 2001 [Credelle Decl.], ¶ 138. While Johnson discloses the use of LEDs as charge indicators (*see* Ex. 1007 [Johnson], 2:11-34), this is a minor

feature of Johnson and is not central to the invention of Johnson, which is primarily concerned with charging multiple batteries in the charger at low power levels by prioritizing the charging of one battery over the others. Ex. 1007 [Johnson], 1:38-45; Ex. 2001 [Credelle Decl.], ¶ 137. Any indicator—including incandescent lights, audio, haptic, or other visual indicia (text, graphical display, etc.)—could be used instead, with similar results. Ex. 2001 [Credelle Decl.], ¶ 137. A POSITA would not look to an invention relating to sequential battery charging for the purpose of adding colored LEDs to Petitioner's proposed combination of Birrell and Logan to arrive at the claimed invention. Ex. 2001 [Credelle Decl.], ¶ 137.

Thus, a POSITA would not look to Johnson to combine with Birrell and Logan.

VI. GROUND 3: CLAIMS 3, 10-12 AND 21 ARE PATENTABLE OVER BIRRELL, LOGAN AND ZHANG

A. Zhang (Ex. 1022)

Zhang (Ex. 1022) is directed toward lighting devices using LEDs. Ex. 1022 [Zhang], Title. In particular, Zhang "relates to 5 lighting devices using Light Emitting Diodes (LEDs): 5-color LED flashlights, chip-on-board LED exit signs, LED traffic lights, LED lamps, and parabolic LEDs." Ex. 1022 [Zhang], ¶[0002]. Zhang Fig. 1.1 (below) is one example of Zhang's 5-color LED flashlight. In

Zhang Fig. 1.1, integrated circuit 6 switches between 5 different color LED filaments a, b, c, d, and e. Ex. 1022 [Zhang], ¶[0072].

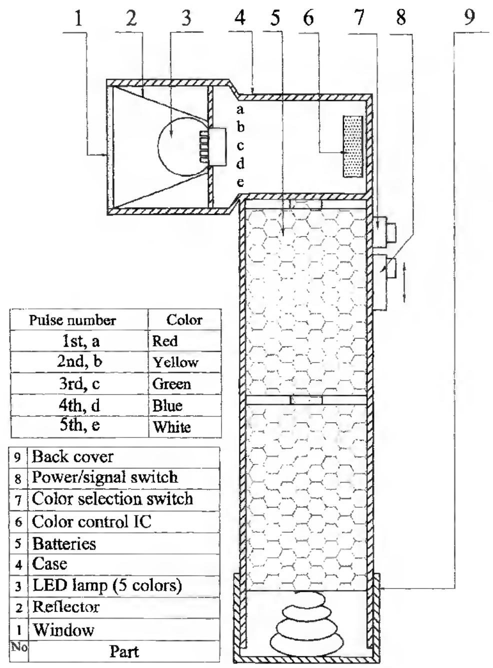


Fig. 1.1. Mechanic diagram of color selecting IC design

B. Claim 3 Is Patentable Over Birrell, Logan and Zhang

Claim 3 is directed to "the apparatus of claim 1, wherein said second device is adapted to receive power from a power supply connected to an AC mains." Ex. 1001 ['298 Patent], Claim 3. The Petition relies on the combination of Birrell and Logan in ground 1 as allegedly disclosing underlying claim 1. Pet., 48. Birrell,

Logan and Zhang do not teach claim 3 at least for the reasons discussed above for ground 1 claims 1 and (as to Birrell and Logan) claim 3.

The Petition argues that Zhang teaches this limitation through its disclosure of a 120V AC input into its system. Pet., 49-50. Even assuming a POSITA would understand Zhang to be referring to AC mains, Petitioner's modified system of Birrell and Logan operates at a high frequency of 80kHz, not the 60 Hz used by AC mains, and the Petition does not explain how or why a POSITA would want to convert 60 Hz AC mains to the 80kHz signal used in Birrell, or even whether it is possible to do so. Ex. 2001 [Credelle Decl.], ¶ 140. Thus, the Petition fails to carry its burden to show that its proposed modification of Birrell and Logan in further view of Zhang would be obvious to a POSITA.

C. Claim 10 Is Patentable Over Birrell, Logan and Zhang

Claim 10 is an independent claim. Claim 10 is patentable over Birrell, Logan and Zhang for at least the reasons discussed above in ground 1 for Birrell and Logan. *See* §§ IV.C and F, above.

The Petition additionally argues that "it would have been obvious to configure the modified tile 50 in the *Birrell-Logan* 'apparatus' (Section IX.A.4) to include a rechargeable battery ('power supply') to provide power to the apparatus in view of *Zhang* as discussed in claim 21 above in Ground 3." Pet., 54. But the

Petition is unclear how the proposed Birrell-Logan combination would be further combined with Zhang to disclose claim 10. *See* 37 C.F.R. § 104(b)(4) ("the petition must specify where each element of the claim is found in the prior art patents or printed publications relied upon.").

To the extent the Petition argues that Zhang's battery should be added to the Birrell-Logan circuit as a power supply, the proposed Birrell-Logan circuit already has a 48V AC power supply as discussed above. *See also* Petitioner Demonstratives E-F. Further, a POSITA would not look to add a battery to the modified system of Birrell and Logan because it would add additional size and expense to the modified tile 50 of Birrell. Ex. 2001 [Credelle Decl.], ¶ 143. In addition, Birrell is teaching a lighting fixture for a house or building, which would not typically use a battery. Ex. 2001 [Credelle Decl.], ¶ 143. To the extent a battery were included in Birrell's lighting tile 50, additional circuitry would be required to switch from the 48V AC input to battery power in circumstances that the 48V AC input is not available. Ex. 2001 [Credelle Decl.], ¶ 143.

Further, Zhang does not teach wireless charging. Ex. 2001 [Credelle Decl.], ¶ 144. Thus, Zhang's battery does not receive power wirelessly from a power source.

Accordingly, the Petition has not demonstrated that the proposed modification of Birrell and Logan in further view of Zhang discloses this limitation.

D. Claim 11 Is Patentable Over Birrell, Logan and Zhang

Claim 11 is dependent from claim 10. Claim 11 is therefore patentable over Birrell, Logan and Zhang for at least the reasons identified above for ground 3 claim 10. *See* § VI.C, above.

E. Claim 12 Is Patentable Over Birrell, Logan and Zhang

Claim 12 is directed toward the apparatus of claim 10, "wherein said apparatus is configured to receive power from an AC mains power supply." Ex. 1001 ['298 Patent], Claim 12. Claim 12 is patentable over Birrell, Logan and Zhang for at least the reasons identified above for ground 3 claim 10. *See* § VI.C, above.

F. Claim 21 Is Patentable Over Birrell, Logan and Zhang

Claim 21 is an independent claim. The Petition argues that "to the extent that the *Birrell-Logan* combination is found not to disclose that 'the first device' includes 'at least one battery' as explained for claim 21 (Ground 1), it would have been obvious to implement a battery in the modified tile 50 ('first device') in the *Birrell-Logan* combination in view of *Zhang*." Pet., 51. Claim 21 is patentable over Birrell, Logan and Zhang for the reasons discussed above for ground 1 claim 21. In

addition, for the reasons discussed above at ground 3 claim 10, a POSITA would not look to incorporate Zhang's battery into the modified tile 50 of the proposed Birrell-Logan combination.

VII. GROUND 4: CLAIM 5 IS PATENTABLE OVER BIRRELL, LOGAN AND SEMBHI

A. Sembhi (Ex. 1008)

Sembhi is directed to a multi-scene preset lighting controller. Ex. 1008 [Sembhi], Title. Sembhi discloses a method for storing preset light intensity levels where "the user adjusts the desired light intensity level using an intensity selector and then presses and holds a preset actuator for a non-transitory period of time to store the light intensity level into memory." Ex. 1008 [Sembhi], Abstract. Sembhi Fig. 5A (below) shows one embodiment of a wall mountable dimmer of Sembhi's lighting control system:

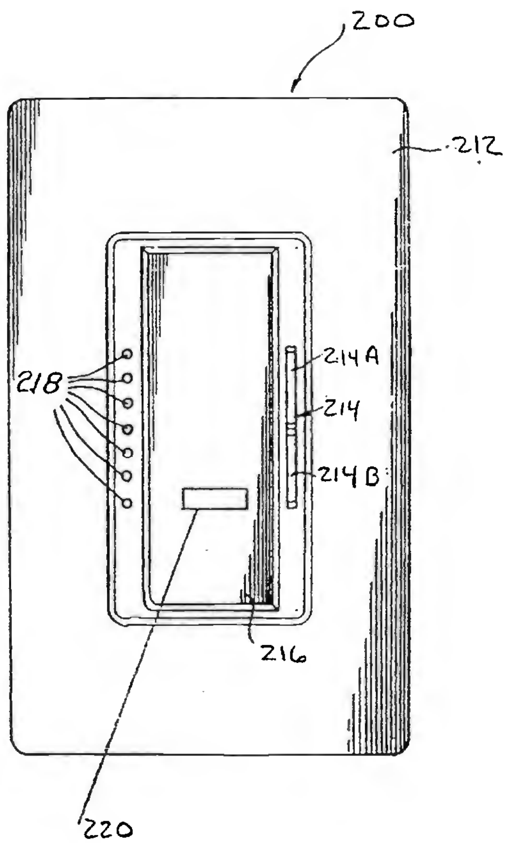


FIG 5A

Sembhi Fig. 5A shows a dimmer 200 with a faceplate 212. Ex. 1008 [Sembhi], ¶[0061]. Sembhi explains that "[w]hen the user actuates the upper portion of the actuator 214 labeled 214A the light level of the attached load increases. When the user actuates the lower portion of the actuator 214 labeled 214B the light level of the attached load decreases." Ex. 1008 [Sembhi], ¶[0061]. In some embodiments, Sembhi discusses that it was known to use a three-way switch. *See* Ex. 1008 [Sembhi], ¶[0018].

B. Claim 5 is Patentable Over Birrell, Logan and Sembhi

Claim 5 claims the apparatus of claim 1, "wherein said second device comprises a three-way switch." Petitioner appears to rely on Birrell and Logan for underlying claim 1. Thus, claim 5 is patentable over Birrell, Logan and Sembhi for at least the reasons described at ground 1, claim 1 above.

VIII. GROUND 5: CLAIMS 6, 18 AND 24 ARE PATENTABLE OVER BIRRELL

A. Claim 6 Is Patentable Over Birrell

Claim 6 is an independent claim. Claim 6 is patentable over Birrell because Birrell does not teach receiving power wirelessly. As discussed above in ground 1 (§ IV.C), a POSITA would not understand the use of capacitors to be wireless power transfer. The fact that all capacitors have some space between their plates does not mean that every circuit using a capacitor is wireless. Indeed, Birrell itself does not describe its capacitive coupling as wireless. Instead, it describes the attachment of the lighting tile to the surface structure as causing capacitors to be "formed" that "couple the lighting elements to the power supply." Ex. 1005 [Birrell], 18:9-12. *See also id.*, 23:15-19 ("the light tile circuitry is structured so that all data is transferred by the same electrical path that is used for the electrical power transfer, that is via the two capacitors formed when the tile is in intimate contact with the supporting structure."). In other words, the joining of the

capacitive strips in Birrell's support structure with the capacitive strips in the lighting tile form a completed circuit.

Accordingly, Birrell does not teach Claim 6.

B. Claim 24 Is Patentable Over Birrell

Claim 24 claims the apparatus of claim 6, "wherein the conductive substance includes a metallic material." Claim 24 is patentable over Birrell for at least the reasons discussed above for claim 6.

IX. GROUND 6: CLAIMS 7, 8 AND 25 ARE PATENTABLE OVER BIRRELL, LOGAN AND CAMRAS

A. Camras (Ex. 1009)

Camras is directed to light emitting diodes with improved light extraction efficiency. Ex. 1009 [Camras], Title. Camras discusses that its "light emitting devices have a stack of layers including semiconductor layers comprising an active region. The stack is bonded to a transparent optical element." Ex. 1009 [Camras], ¶[0011].Camras Fig. 6 below is "an optical element directly bonded to a light emitting diode having a 'flip chip' geometry" in one of Camras' embodiments. Ex. 1009 [Camras], ¶[0025].

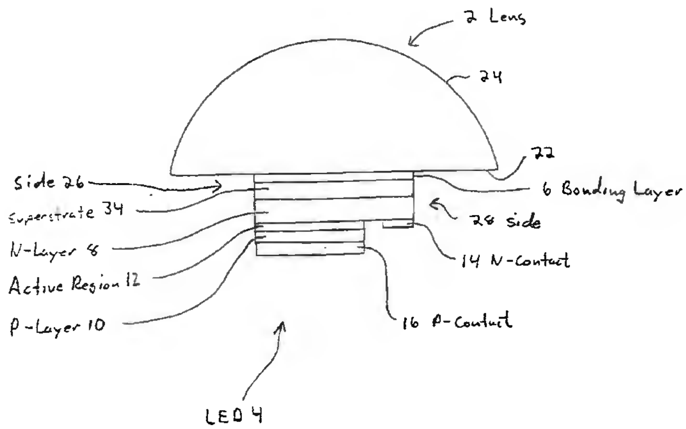


FIG. 6

"In the embodiment illustrated in Fig. 6, optical element 2 is bonded with bonding layer 6 to transparent superstrate 334. " Ex. 1009 [Camras], ¶[0069].

B. Claim 7 Is Patentable Over Birrell, Logan and Camras

Claim 7 is an independent claim. Claim 7 is patentable over Birrell, Logan and Camras for at least the reasons discussed above for ground 1 claims 1 and 10. *See* §§ IV.C and F, above. In particular, neither Birrell nor Logan teaches the claimed antenna, and a POSITA would not look to combine Logan's coils into the capacitive coupling system of Birrell.

C. Claim 8 Is Patentable Over Birrell, Logan and Camras

Claim 8 claims the apparatus of claim 7, "wherein said apparatus is configured to provide power to said LED circuit after detection of a touch." Ex.

1001 ['298 Patent], claim 8. Claim 8 is patentable over Birrell, Logan and Camras for at least the reasons discussed for claim 7 above.

D. Claim 25 Is Patentable Over Birrell, Logan and Camras

Claim 25 claims the apparatus of claim 7, "wherein the conductive substance includes a metallic material." Claim 25 is patentable over Birrell, Logan and Camras for at least the reasons discussed for claim 7 above.

X. GROUND 7: CLAIM 9 IS PATENTABLE OVER BIRRELL, LOGAN AND GLEENER

A. Gleener (Ex. 1010)

Gleener is directed toward a tunable dual band antenna system. Ex. 1010 [Gleener], Title. The system includes a transceiver, a matching network, and an antenna. Ex. 1010 [Gleener], Abstract. Fig. 3, below, is a circuit diagram of an antenna matching network and antenna constructed in accordance with the invention.

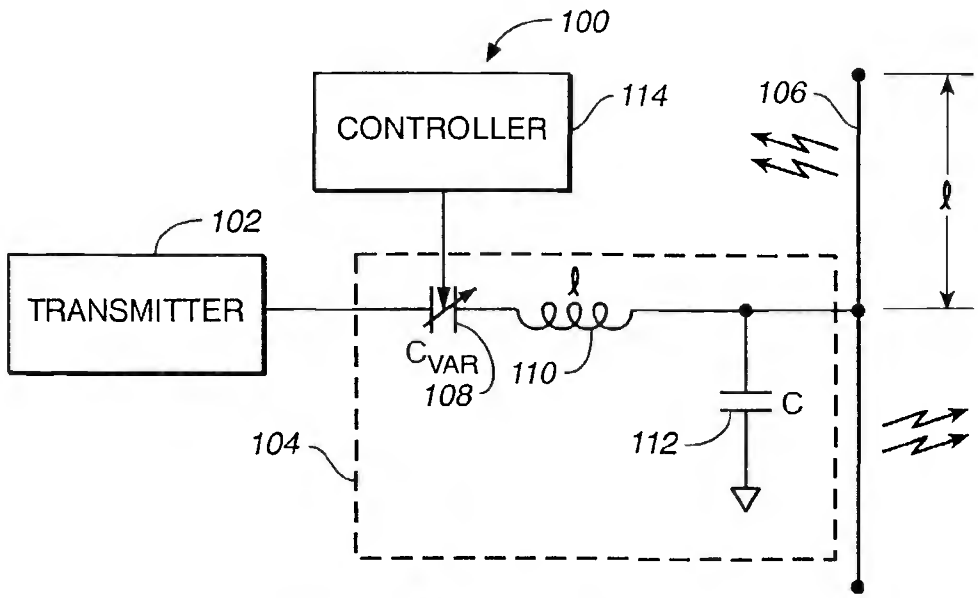


FIG._3

As seen in Gleener Fig. 3, "matching network 104 has a variable capacitor 108 with a first lead electrically connected to the transceiver 102" and "a second lead of the variable capacitor 108 is electrically connected to a first lead of an inductor 110." Ex. 1010 [Gleener], ¶[0021]. The inductor 110 is then connected to the antenna 106. Ex. 1010 [Gleener], ¶[0021]. Capacitor 112 is connected between the inductor 110 and antenna 106 and is grounded. Ex. 1010 [Gleener], ¶[0021]. Gleener does not discuss or disclose LEDs or lighting more generally.

B. Claim 9 Is Patentable Over Birrell, Logan and Gleener

Claim 9 is an independent claim. The Petition relies on Birrell in view of Logan as disclosing claim 9(c)("a data receiver, wherein the data receiver is

configured to receive data from an antenna.") for the same reasons discussed in the Petition for claim 10(c). Pet, 66. Thus, claim 9 is patentable over Birrell, Logan and Gleener for the same reason discussed above for ground 1 claims 1 and 10. *See* §§ IV.C and F. In particular, neither Birrell nor Logan teaches the claimed antenna, and a POSITA would not look to combine Logan's coils into the capacitive coupling system of Birrell.

XI. GROUND 8: CLAIM 16 IS PATENTABLE OVER BIRRELL, LOGAN AND RAHMEL

A. Rahmel (Ex. 1011)

Rahmel is directed to methods and system for energy reclamation and reuse. Ex. 1011 [Rahmel], Title. In particular, Rahmel relates to the integration of antennas and electronics for harvesting radio frequency (RF) energy, transforming such electromagnetic energy into electrical power, and storing such power for usage with a wide range of electrical/electronic circuits and modules. Ex. 1011 [Rahmel], Abstract. Rahmel Fig. 7 (below) shows a high level schematic diagram of an energy harvesting subsystem according to one embodiment of Rahmel. Ex. 1011 [Rahmel], 4:8-10.

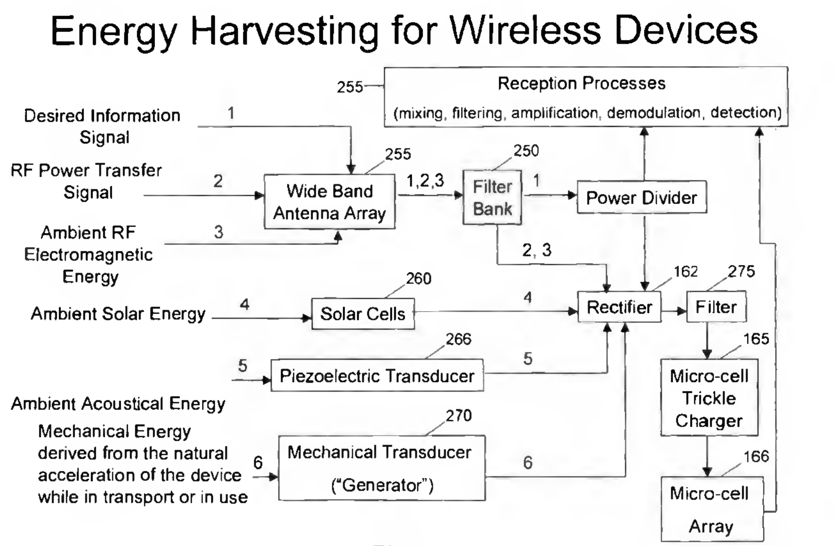


Fig. 7

Notably, Rahmel does not discuss or disclose LEDs or lighting in general.

B. Claim 16 Is Patentable Over Birrell, Logan and Rahmel

Claim 16 is an independent claim. The Petition relies on the combination of Birrell and Logan in ground 1 claim 10 for limitations 16 (a)-(c) and (e) and ground 1 claim 17 for limitation 16 (f). Pet., 71-74. Thus, Claim 16 is patentable over Birrell, Logan and Rahmel for the at least the reasons described above for those claims. *See* §§ IV.C, F and L.

XII. GROUND 9: CLAIM 22 IS PATENTABLE OVER BIRRELL, LOGAN AND SONTAG

A. Sontag (Ex. 1012)

Sontag is directed to a signal transmission system. Ex. 1012 [Sontag], Title. In particular, Sontag is directed toward transmitting radio frequency signals across

a barrier. Ex. 1012 [Sontag], Abstract. Sontag Fig. 1 is a diagram of a signal transmission system in one embodiment of Sontag. Ex. 1012 [Sontag], 2:53-54.

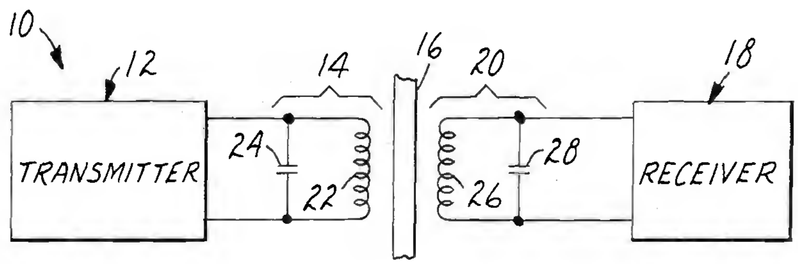


FIG. 1

Sontag explains:

> A transmitter 12 is operatively coupled to a transmitting antenna 14 positioned on one side of a boundary or barrier 16. On the opposite side of the barrier or boundary 16 a receiver 18 is operatively coupled to a receiving antenna 20. In a preferred embodiment, the transmitting antenna consists of a resonant LC circuit involving inductor 22 and capacitor 24. Similarly, in a preferred embodiment, receiving antenna 20 also comprises an LC circuit consisting of inductor 26 and capacitor 28.

Ex. 1012 [Sontag], 2:65-3:6. Sontag does not disclose or discuss LEDs or even lighting more generally. Further, Sontag is limited to the wireless

transmission of radio frequency signals and does not involve the wireless transfer of power.

B. Claim 22 Is Patentable Over Birrell, Logan and Sontag

Claim 22 is an independent claim. The Petition relies on the combination of Birrell and Logan as discussed above for each limitation other than limitation 22(d) relating to transmission of power and signals wirelessly using resonance and inductance. A POSITA would not look to combine Birrell and Logan for Claim 22 as discussed above in ground 1 claim 1.

XIII. CONCLUSION

For the foregoing reasons, the remaining claims of the '298 Patent should be affirmed.

Respectfully submitted,

/James T. Carmichael/
James T. Carmichael, Reg. No. 45,306
CARMICHAEL IP, PLLC

Date: June 21, 2022

CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITS

This Patent Owner Response (the "POR") consists of 10,021 words, excluding table of contents, table of authorities, certificate of service, this certificate, or table of exhibits. The POR complies with the type-volume limitation of 14,000 words as mandated in 37 C.F.R. § 42.24. In preparing this certificate, counsel has relied on the word count of the word-processing system used to prepare the paper (Microsoft Word).

Respectfully submitted,

/Stephen McBride/

Date: June 21, 2022

CERTIFICATE OF SERVICE

The undersigned hereby certifies that the following documents were served by electronic service, by agreement between the parties, on the date below:

PATENT OWNER'S RESPONSE

EXHIBITS 2001-2005

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Date: June 21, 2022

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD,
Petitioner,

v.

LYNK LABS, INC.,
Patent Owner

Case IPR2021-01347
Patent 10,966,298

PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE

I. INTRODUCTION

Petitioner Samsung Electronics Co., Ltd. replies to the Patent Owner Response (Paper No. 18, "POR") filed by Patent Owner ("PO") concerning challenged claims 1-17 and 21-22 of U.S. Patent No. 10,966,298 ("the '298 patent").[1]

II. CLAIM CONSTRUCTION AND POSITA DEFINITION

PO agrees all claims should be given their plain meaning (POR, 12), and that no constructions are necessary. (Pet., 5-6.) Although PO contests Petitioner's POSITA definition (POR, 11), such issues relating to the parties' definition are not dispositive given the overlap and minor differences. (Pet., 4; POR, 10; Ex. 2003, 22:4-29:10.)

III. GROUND 1: CLAIMS 1, 3, 4, 10-15, 17, 21, AND 23

As a backdrop, PO's arguments against the *Birrell-Logan*-based combinations hinge on PO's mistaken position that the modifications rely on a bodily incorporation of *Logan*'s coils into *Birrell*'s system. (*See e.g.,* POR, 19 ("[t]he Petition argues that a POSITA would want to incorporate Logan's coils into Birrell"), 21, 26-27, 38-39, 51, 54; Ex. 2001, ¶¶78, 81-84.) PO even argues against **modifications to *Logan***—*not Birrell*. (*See* POR, 26; Ex. 2001, ¶91; Ex. 1119,

[1] PO disclaimed claims 18-20. (Ex. 2004.)

("capacitive strips…still able to provide power to tile element 50"); Ex. 1119, 87:17-88:8, 119:15-25.)

Second, *Birrell*'s capacitive coupling does wirelessly transfer power. (POR, 17-18, 20.) Similar to inductive coupling, the capacitive coupling described by *Birrell* was known as a form of wireless power/data transfer. (Ex. 1002, ¶77; Ex. 1118, ¶¶4-5; Ex. 1126, Abstract, Figs. 1A-3, 1:6-67, 2:1-13, 2:56-64, 6:14-18, 6:25-26 (inductive and capacitive coupling for "wireless" transfer); Ex. 1131, 1:10-67, 8:52-65; Ex. 1132, 2:18-3:37, 4:49-5:6, 14:28-16:57; Ex. 1133, Abstract, 6:54-67, 102:33-43, 113:64-114:20, 115:56-57, 137:18-19, 144:47-65; Ex. 1134, ¶¶0002-0005, 0014, 0021.) While PO's expert, Mr. Credelle, agreed inductive coupling was a known type of wireless power transfer (Ex. 1119, 23:21-24:15, 25:5-12), he never investigated how a POSITA would have understood what capacitive coupling meant in context of transferring power like that described in *Birrell* (*id.*, 25:13-27:8). Instead, PO relies on an overly-simplistic view as to how capacitors operate. (POR, 20; Ex. 1119, 25:23-26:9; Ex. 2001, ¶80; POR, 20.) That view ignores how *Birrell* uses separated conductive elements to transfer power/data, consistent with a POSITA's understanding of capacitive-coupling in such applications (Ex. 1118, ¶5; Ex. 1005, 2:36-3:21, 4:8-11, 5:1-6, 8:31-34; Ex. 1119, 41:17-23, 49:25-54:5, 58:13-59:16, 72:10-24, 73:1-19, 90:1-7) and with Mr. Credelle's understanding of the claimed "wireless[]" power transfer (Ex. 1119, 22:15-23:20). Notably, even if PO

of-art knowledge of a POSITA that frames the asserted combination. (Pet., 51-56.) The *Birrell-Logan-Zhang* combination does not rely on a bodily incorporation of *Zhang*'s battery in to *Birrell*'s system. (*Id.*)

Regarding claims 11, 12, and 21, PO relies on its arguments concerning claim 21 in Ground 1 and/or its arguments concerning claim 10 for Ground 3 (POR, 46-47). Accordingly, for the same reasons explained above, PO's arguments should be rejected.

VI. GROUND 4: CLAIM 5

PO's arguments regarding **claim 5** (POR, 49) should be rejected for the same reasons regarding claim 1 (Ground 1) explained above. (*Supra* §III.)

VII. GROUND 5: CLAIMS 6 AND 24

Regarding claim 6, PO argues *Birrell*'s capacitive coupling arrangement does not provide wireless power transfer. (POR, 49-50.) PO's positions are contradicted by *Birrell* and by its own representations.

As explained *supra* §III, the capacitor elements in *Birrell* are physically separated and transfer power and data without wires. (Ex. 1005, 2:36-3:21, 4:8-11, 5:1-6, 8:31-9:29, 13:15-23; Ex. 1119, 41:17-23, 49:25-54:5, 58:13-59:16, 72:10-24, 73:1-19, 90:1-7, 95:25-96:20; Ex. 1118, ¶4.) A POSITA would have thus understood that the capacitive coupling features described by *Birrell* transfer power (and data) between physically separated elements and thus disclose wireless

power/data transfer similar to that known in the art for similar capacitive coupling configurations. (Ex. 1002, ¶77; Ex. 1118, ¶¶4-5; Ex. 1126, Abstract, Figs. 1A-3, 1:6-67, 2:1-13, 2:56-64, 6:14-18, 6:25-26; Ex. 1131, 1:10-67, 8:52-65; Ex. 1132, 2:18-3:37, 4:49-5:6, 14:28-16:57; Ex. 1133, Abstract, 6:54-67, 102:33-43, 113:64-114:20, 115:56-57, 137:18-19; Ex. 1134, ¶¶0002-0005, 0014, 0021.) PO's argument should be given little weight given Mr. Credelle never considered how a POSITA would have understood what capacitive coupling meant in context of transferring power like that described in *Birrell*. (Ex. 1119, 25:13-27:8.) Nor did PO dispute that *Birrell* discloses "***transmitting or receiving data signals <u>wirelessly</u>***" recited in limitation 6(c). (POR, 49-50; Pet., 58-59.) *Birrell* discloses limitation 6(c) based on the same components that PO argues do not disclose wirelessly receiving power. (Pet., 58-59; Ex. 1005, FIG. 8, 8:31-9:10, 9:11-29, 13:15-23, 23:15-21.)

PO's arguments regarding **<u>claim 24</u>** (POR, 50) should be rejected for the same reasons regarding claim 6 explained above.

VIII. GROUNDS 6-9

Regarding **<u>claims 7, 8, 25 (Ground 6), 9 (Ground 7), 16 (Ground 8), and 22 (Ground 9)</u>**, PO relies on its arguments concerning claims 1, 10, and/or 17 for Ground 1 (POR, 51-57). Accordingly, for reasons explained above for those claims, PO's arguments should be rejected.

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.
Petitioner,

v.

LYNK LABS, INC.,
Patent Owner.

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U.S. Patent No. 10,966,298

PATENT OWNER'S SUR-REPLY

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2001	Declaration of Dr. Thomas Credelle
2002	CV of Dr. Thomas Credelle
2003	Deposition Transcript of Dr. Jacob Baker
2004	Statutory Disclaimer, Claims 18-20 of '298 Patent
2005	*Excerpts from* Gibilisco, The Illustrated Dictionary of Electronics, McGraw-Hill, 8th Ed., 2001.

I. INTRODUCTION

U.S. Patent No. 10,966,298 (the "'298 Patent") is directed towards LED lighting systems, including those driven using AC power. Ex-1001 ['298 Patent], Title. Nothing in Petitioner's Reply overcomes (or directly addresses) Birrell's clear teachings that it does not transfer power wirelessly. Further, Petitioner's arguments fail to identify how the cited prior art discloses other claim limitations, including power supplies adapted to receive power wirelessly from a power source and receiving data from an antenna. For many elements, Petitioner relies on alleged state of the art rather than actual disclosure in a prior art reference. Because the prior art presented in the Petition does not disclose a number of claim limitations and fails to specify how the remaining disclosed claim limitations could be combined, Petitioner's Reply improperly relies on new extrinsic evidence and misleadingly characterizes to PO's expert testimony rather than addressing the prior art itself.

For the reasons set forth below, the Petition and Reply fail to demonstrate by a preponderance of the evidence that claims 1-17 or 21-25 of the '298 Patent are unpatentable.[1]

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[1] Patent Owner disclaimed claims 18-20. Ex-2004.

II. GROUND 1: CLAIMS 1, 3-4, 10-15, 17, 21 AND 23 ARE PATENTABLE OVER BIRRELL AND LOGAN

Ground 1 of the Petition alleges that claims 1, 3-4, 10-15, 17, 21, and 23 are obvious based on Birrell and Logan. Pet., 2. As discussed below, this is incorrect.

A. Claim 1 Is Patentable Over Birrell and Logan

Petitioner's Reply fails to demonstrate that a POSITA would look to combine Birrell and Logan to arrive at the invention of claim 1. The Reply argues that it would have been "obvious to modify Birrell's system to use inductive coupling in place of capacitive coupling to wirelessly transfer power/data." Reply, 2. This is incorrect.

First, Petitioner argues that "PO never considered Birrell's implementations where RF signals are transmitted/received by the lighting devices." Reply, 4. This is because nothing in Birrell or the '298 Patent indicates interference issues, whether due to RF signals or otherwise. Reply, 2. Tellingly, the Reply argues "RF signals were a source of *potential* interference in Birrell" (Reply, 4 (emphasis added)) without identifying any place in Birrell that mentions interference. Thus, the Reply speculates that Birrell's mention of RF transmissions in certain embodiments *could* cause a POSITA to infer there *might* be interference issues with Birrell's capacitors.

However, Petitioner provides *no evidence* that capacitors create wireless interference issues. Further, the embodiments of Birrell that transmit data with power across Birrell's capacitors are *an alternative* to the radio frequency transmission embodiments. Ex-1005 [Birrell], 8:14-20 ("Data communication between devices … may be achieved by means *of wireless techniques* such as radio frequency … *or direct connection* such as modulation of the external power source used by the device."). Birrell's capacitors—which in some embodiments carry data modulated onto an external power source—are a "direct connection." *Id. See also* Ex-1005 [Birrell], 23:18-19 ("two capacitors formed when the tile is in intimate contact with the supporting structure."). Thus, to the extent a POSITA could potentially understand RF transmissions in Birrell might potentially cause interference (despite Birrell's silence on the issue), transmitting data with Birrell's power (and therefore through its capacitors) would remove the need to use such RF transmissions.

Logan also teaches using data on wireless power as an alternative *to radio transmissions.* Ex-1006 [Logan], 1:6-17. However, Petitioner's combination seeks to use Logan's inductive coupling as an alternative to Birrell's *capacitors*. Reply, 2. In other words, Petitioner seeks to modify Birrell's capacitors, not Birrell's generic teachings regarding RF transmissions.

Petitioner also argues that capacitors are wireless transmitters because certain of PO's statements indicate power is transferred through the capacitors. Reply, 2-3. However, power is transferred by every circuit element. By Petitioner's logic, every circuit element that carries an electric charge is a "transmitter."

Petitioner, citing its supplemental expert report and other extrinsic evidence, next argues that capacitors transmit power wirelessly. Numerous circuit elements conduct electricity without using literal wires but are not considered to transfer power "wirelessly." These include not only capacitors, but transformers, turbines, and fluorescent lights (gas), for example. Indeed, most transistors operate by transferring power over semiconductor materials that are not literally "wires."

Petitioner's expert argues that capacitors are wireless because they are "physically separated conductive elements." Ex-1118, ¶4. But numerous electrical elements—outlets, plugs, light bulbs, batteries, etc.—can be physically separated and do not transmit power wirelessly. Further, the capacitive plates in Birrell *are physically connected* (by magnets) when transferring power. Ex-1005 [Birrell], 10:24-25 ("the present invention provides a lighting element suitable for connection to a power source.").

The fact that Birrell has a thin dielectric layer between its plates does not make Birrell wireless. Every capacitor has a thin dielectric material between its

plates. Ex-2001 [Credelle Decl.], ¶¶76, 80. To the extent that the dielectric gap in Birrell's capacitors is considered "wireless", every circuit utilizing a capacitor would be "wireless." *Id.* The distance between connected capacitor plates in Birrell is "0.05mm" (Ex-1005 [Birrell], 21:32-33), which is somewhere around the thickness of a human hair. Contrast this to Logan's teachings of panel thicknesses "in the range of 3mm to 6mm" (Ex-1006 [Logan], 5:2-4), which is around 100 times thicker than the dielectric insulator of Birrell and comparable to the thickness of a pencil. Reply, 7. There is no similar thick gap in Birrell's capacitors.

Petitioner newly cites several extrinsic references that allegedly discuss wireless power and capacitive coupling. Reply, 3-4. The issue isn't whether capacitive coupling could potentially be used to transfer power; it is that Birrell is not teaching wireless power transfer. Birrell's single use of the word "wireless" distinguishes between data transmission using "wireless techniques such as radio frequency" and "direct connection such as modulation of the external power source used by the device." Ex-1005 [Birrell], 8:14-20. Thus, Birrell explicitly teaches that "modulation of the external power source" (as used by Birrell's capacitors) is a "direct connection," not a "wireless technique." *Id.*

Birrell's teachings that capacitors constitute a direct connection is conventional; virtually every electronic device contains capacitors, yet the

inclusion of capacitors in a device does not transform those devices into wireless devices. Further, the fact that Birrell's lighting tile is separable from the wall also does not transform it into a wireless device. Instead, this feature is a convenient alternative to conventional methods like screws. *See, e.g.,* Ex-1005 [Birrell], 15:8-14 ("the use of a magnetic force to mount the tile to a supporting structure…provides a convenient system whereby the tile 50 may be secured and removed from a supporting structure which incorporates an appropriate magnetic receptor without damage to that supporting structure."). In other words, Birrell's goal is the convenient attachment of a lighting tile using magnets. *See* Ex-1005 [Birrell], 2:14-35. The use of capacitors in Birrell is to further this goal in a safe and efficient manner, not to transfer power wirelessly.

A POSITA would not look to incorporate wireless transmission in Birrell because it is unnecessary to achieving Birrell's goal of providing a convenient and safe way to attach a lighting tile. This contrasts with Logan's goal, which is "transmitting power and/or data" through "a solid wall, such as a metal plate forming an instrument panel or bulkhead." Ex-1006 [Logan], 1:3-10. Logan's teachings to arrange its inductors to produce a "concentrated and localized" magnetic field that transmits power wirelessly through solid materials makes Logan's power transmission wireless. Ex-1006 [Logan], 6:3-11. In Birrell, there is

no need to transmit power through a "solid wall" because Birrell's capacitors are already optimized for efficient power transfer.

Petitioner further argues that "PO's assumption the Birrell-Logan combination requires Logan's coils to facilitate voltage magnitude adjustments is misplaced." Reply, 5. But PO's argument quotes the Petition, which stated "a POSITA would have appreciated that using inductive coupling to provide wireless power in Birrell would allow for voltage magnitude adjustments by adjusting the windings of the coils." POR, 18 (quoting Pet., 14). PO's point is that Logan is teaching a concentrated magnetic field for transmitting power through a barrier, not stepping voltage down in a manner that is consistent with transformer operation. *Id.* It would not make sense to use Logan's coils as a transformer because Logan's coils are optimized to maximize power transfer through a thick panel, not to regulate voltage. Ex-1006 [Logan], 5:2-4. Further, there is no indication in Birrell that its voltage levels need adjustment; to the contrary, the LEDs of Birrell are designed to operate at the 48V provided by the power supply. Ex-1005 [Birrell], 22:13-30.

Petitioner argues that "providing the ability to adjust voltage levels" by incorporating transformers into Birrell would be advantageous "to accommodate other LED circuit designs (e.g., more/fewer LEDs)." Reply, 7. But there are many

places to adjust voltage other than where Birrell's lighting element connects to the surface and many ways to adjust voltage that do not involve transformers. Replacing Birrell's flat, thin capacitors with thick, bulky transformers would add size, weight, and complexity to the system and result in a less efficient design. POR, 18-20, Ex-2001 [Credelle Decl.], ¶¶82-94.

Petitioner next argues that Logan's teaching of transmitting power over a space "at least 100 times wider than" Birrell would have been an improvement to Birrell. Reply, 6-7. But this underscores the fact that Birrell does not involve wireless power transmission. The goal in Birrell is ***thin*** lighting elements for "flush mounting" and easy attachment (Ex-1005 [Birrell], 2:14-17). Further, regardless of the technology used, inserting a thick barrier of the type discussed in Logan in place of Birrell's razor thin dielectric layer would likely lead to a massively more inefficient power transfer. Ex-2001 [Credelle Decl.], ¶79.

Petitioner argues that "using inductive coupling with Birrell would have predictably provided an efficient/effective power transfer mechanism." Reply, 8. But nothing in Birrell indicates its capacitors are inefficient or ineffective, and Petitioner never explains why inductive coupling would improve the efficiency or effectiveness of Birrell's capacitors. Indeed, as discussed above, Birrell does not

involve wireless power transfer, and introducing wireless power transfer via inductors to Birrell would result in much less efficiency.

Fifth, Petitioner argues that a POSITA could use "planar, spiral and similar thin form factor loop inductors" in place of the iron-cored coils of Logan and therefore avoid the problems associated with incorporating the bulky, high-voltage coils of Logan into Birrell. Pet., 8-10. Thus, Petitioner argues to incorporate coils other than those taught by Logan into Birrell's system. *See, e.g.,* Reply, 8-9 ("By incorrectly focusing on Logan's coils being added to Birrell's system, PO misses that a POSITA would have been aware and capable of designing inductor-based power/data transfer mechanisms using various configurations and form factors having minimal thickness."). However, Petitioner's reference for introducing wireless power transfer into Birrell ***is*** Logan, which require bulky, high-voltage iron-cored coils.

Tacitly acknowledging a POSITA would not introduce wireless power transfer into Birrell by replacing Birrell's capacitors with Logan's bulky coils. Petitioner cites numerous extrinsic references ***filed for the first time*** with its Reply that purportedly disclose thin inductors. Reply, 9 (citing Exs. 1117, 1121-1126). None of these references were relied upon or referred to in the Petition and should not be considered here. Most do not appear particularly relevant. For example, Ex-

1117 is a patent filed by PO's expert, Dr. Thomas Credelle, that involves inductors used as part of RFID tags. Petitioner does not explain why RFID tags are relevant to the issue of wireless power transfer. Further, Petitioner does not identify why any of these new references demonstrate a rationale for introducing wireless power transfer into Birrell in the first place.

Petitioner disagrees that Birrell "generally is designed for 'lower degree of alignment accuracy' [ ] and 'placement flexibility'". Reply, 10 (citing POR, 22, 25-26.) Petitioner's argument appears to be that only certain embodiments of Birrell teach increased flexibility of placement (Reply, 10), but this does not address Birrell's stated goal of "enhanced flexibility for installation and control" or the obvious implication that Birrell will still operate at reasonable efficiency in any embodiment even if its magnets are not perfectly aligned. Ex-1005 [Birrell], 2:31-35; POR, 22-23. The same is not true of Logan's concentrated magnetic field, where a slight misalignment could lead to poor efficiency or even complete inoperability. Ex-2001 [Credelle Decl.], ¶¶58, 90-91.

Petitioner argues, without explanation, that "modifying Birrell with inductive coupling" would provide "greater alignment freedom." Reply, 11. Petitioner's expert states that inductive coupling would "provide for more freedom in alignment than the capacitive coupling", but aside from that conclusory

statement, its expert provides no rationale. *Id.* Petitioner also cites previously undisclosed Ex-1122, but does not explain what Ex-1122's relevance is to adding the wireless power transfer via inductive coupling taught in Logan to Birrell. Nor does Petitioner address why Logan's "concentrated magnetic field"—in effect, a focused beam—provides greater alignment freedom than the capacitors of Birrell with their much larger surface area and magnetic attachment. Even if Petitioner were correct that "a shift in alignment of Birrell's plates would decrease efficiency" (POR, 11), a POSITA would understand a shift in alignment for Logan's concentrated magnetic field would leave Logan's wireless power transfer inoperable.

Petitioner argues that "PO ignores that Birrell does not require the use of magnetic sheet 57 as shown in Figure 1." Reply, 12. While Birrell does teach that its light can be secured in "any suitable manner", in "the preferred form" (and every figure and disclosed embodiment) "the device or the element is affixed [ ] by a permanent magnetic force." Ex-1005 [Birrell], 6:31-36. Further, the Petition does not appear to rely on or discuss any Birrell embodiment using anything other than magnetic attachment.

Petitioner argues that, if implemented on a table, "gravity alone could hold device 51 on top of the surface components." POR, 12. However, Birrell indicates

the lighting element is "secured to the supporting surface" (Ex-1005, 6:31-34) and a lighting device that is simply resting on a tabletop is not "secured" to anything. The implication in Birrell is that even lights on a table would preferably be secured with magnets.

Petitioner argues "inductive coupling would eliminate the need for defacing the tabletop" but does not explain why using Birrell's capacitors would deface the tabletop. Indeed, Birrell discloses the dielectric covering the capacitor plates is "comprised of a surface finish suitable for the area" that "contribute to the improved efficiency of the power transfer across the capacitive coupling." Ex-1005 [Birrell], 5:34-6:8. Thus, not only does Birrell teach using dielectric layers that matches the surface (no need for defacing), those layers contribute to improved efficiency of power transfer.

The Reply's arguments to combine Logan and Birrell are based on the incorrect characterization of Birrell as a wireless power reference. But nothing in Birrell has anything to do with wireless power transfer and "direct connections" like those disclosed in Birrell are generally preferable to wireless power transfer for efficiency purposes. Ex-2001 [Credelle Decl.], ¶¶79, 90-91. Accordingly, a POSITA would not incorporate Logan's wireless power transfer or inductive coupling into Birrell.

B. Claim 3 Is Patentable Over Birrell and Logan

Claim 3 is directed to "the apparatus of claim 1, wherein said second device is adapted to receive power from a power supply connected to an AC mains." Ex-1001 ['298 Patent], Claim 3. The Reply concedes that neither Birrell nor Logan disclose a power supply connected to AC mains. Reply, 15 ("That Birrell or Logan does not explicitly mention AC mains would not have deterred a POSITA from implementing the claimed features as set forth in the Petition."). Reply, 15.

Petitioner's argument that, despite the prior art's failure to disclose a power supply connected to an AC mains, a POSITA would have connected the modified Birrell-Logan system's power supply to AC mains (Reply, 15-16) is therefore supplying a limitation that is entirely missing from any of the prior art. This is exactly the type of gap-filling *Arendi* and related cases warn against. *Arendi S.A.R.L. v. Apple Inc.*, 832 F.3d 1355, 1361 (Fed. Cir. 2016) (" common sense is typically invoked to provide a known *motivation to combine*, not to supply a missing claim limitation."). (emphasis in original). As discussed in the POR, the Petition does not meet the analysis required by *Arendi* and similar cases. POR, 29-30. Petitioner's arguments should be rejected on that basis alone.

Petitioner argues that *Arendi* does not apply because "the word 'common sense' is not used anywhere in the Petition." Reply, 16. But whether described as

"common sense", "common knowledge", "state-of-the-art" or similar, the issue is the same—whether it is appropriate to use a POSITA's alleged knowledge of the art as a substitute for a limitation that is "admittedly missing" from the prior art. *Arendi*, 832 F.3d at 1361-62.

In situations like the present, *Arendi* requires Petitioner to establish (1) the limitation is "unusually simple and the technology particularly straightforward" (2) the limitation "plays a major role in the subject matter claimed and affects much more than [the current limitation]" and (3) the gap-filling is supported with "reasoned analysis and evidentiary support." *Id.* at 1362. Petitioner fails all three.

The Reply argues that "PO did not assert or provide any evidence to support that using AC mains as claimed 'play[s] a major role in the subject matter claimed." Reply, 16. The Reply has it backwards. It is Petitioner's burden to prove unpatentability, not PO's burden to prove patentability. 35 U.S.C. § 316(e). This is especially true in disfavored cases such as here. *Arendi*, 832 F.3d at 1362 ("In cases in which 'common sense' is used to supply a missing limitation, as distinct from a motivation to combine, [the] search for a reasoned basis for resort to common sense must be searching."). The Petition provides no analysis of this issue. Pet., 22-24.

Petitioner argues that the recited power supply connected to an AC mains does not play a major role in the subject matter claimed because "the '298 patent provides no disclosures of the claimed feature." Reply, 16. This is incorrect. For example, the '298 Patent teaches:

> an LED circuit driver provides a relatively fixed voltage and relatively fixed frequency AC output such as mains power sources. The LED circuit driver output voltage and frequency delivered to the LED circuit may be higher than, lower than, or equal to mains power voltage and frequencies by using an LED circuit inverter driver.

Ex-1001 ['298 Patent], 7:12-18. Thus, the '298 Patent teaches using a driver such as an "LED circuit inverter driver" to modify mains power input to an LED circuit.

Finally, besides arguing that "[u]se of AC mains was nothing innovative at the time, especially for Birrell's residential applications" (Reply, 15), the Reply has little in the way of reasoned analysis or evidentiary support to shore up its position. For example, the Reply does not address the POR's analysis of why "the system of Birrell would have to be redesigned to use AC mains." POR, 30-31. Accordingly, Birrell and Logan do not teach claim 3 at least for the reasons discussed above for claim 1.

C. Claim 10 Is Patentable Over Birrell and Logan

Claim 10 is an independent claim and is patentable for the same reasons identified in claim 1 as well as the Patent Owner Response (POR). POR, 32-37.

1. Birrell and Logan do not disclose or suggest a power supply configured to receive power wirelessly from a power source

With respect to the "power supply configured to receive power wirelessly from a power source," the claim requires both (1) a power supply ***and*** (2) a power source. In contrast, Birrell only teaches one—a "48V AC power supply"—which Petitioner argues is the claimed "power source." POR, 32-33 (quoting Ex-1005 [Birrell], 17:25-28, 17:34-36.).

Petitioner argues that Birrell's "48V AC power supply" "has no bearing on the fact that the bridge rectifier components [of Petitioner's hypothetical Birrell-Logan combination] provides power consistent with the plain language of the claims." Reply, 17-18. Petitioner's argument has several defects. First, claim 10 requires a "power supply" and Birrell discloses a "48V AC power supply." POR, 32-33. Petitioner does not explain why a POSITA would understand Birrell's "power supply" to satisfy the claim limitation "power source" rather than "power supply."

Second, Petitioner provides no explanation for why Birrell's "bridge rectifier components" would be considered a "power supply." Reply, 18-19. The Reply

cites to Ex-1002 at ¶¶92-93, where Petitioner's expert simply states that the rectifier and coils of its hypothetical Birrell-Logan combination "disclose[ ] claim 10's 'power supply' because it provides power to power LEDs 59 in the 'apparatus.'"). *Id.* Petitioner has not proposed that "power supply" should be construed "as any circuit element that provides power," and such a construction would fail because it is so broad it would include any wire transmitting power as a "power supply."

Third, elsewhere, the Petition identifies the claimed "power supply" as Birrell's "48V AC power supply." *See* Pet., 22 (alleging that Birrell discloses the claimed "power supply connected to AC mains" because "Birrell discloses a 'second device' (modified tile 50) that wirelessly receives power from a 48V AC power supply."). Thus, when it suits Petitioner to identify Birrell's "48V AC power supply" as the claimed "power supply", Petitioner does so. Petitioner cannot have it both ways.

Fourth, while Petitioner argues that the bridge rectifier and coils from its demonstratives D and E constitute a "power supply," these demonstratives are imaginary mockups from several different references—that is, the coils in demonstrative D are from Logan, and the bridge rectifier is from Birrell. Pet., 16-17, 28-29. Thus, the "power supply" identified by Petitioner for claim 10 is not

actually taught in any prior art of record, instead it *is a hypothetical illustration of an illusory combination of prior art components* misleadingly arranged to appear as if it is disclosed in the prior art. In other words, none of the prior art discloses the "power supply" imagined by Petitioner.

Petitioner argues that PO's identification of Birrell's "48V AC power supply" as "a 'power supply' is nonsensical." Reply, 18. Petitioner's position is inconsistent with the plain language of Birrell and its own argument that any circuit element that "transfer[s] power" is a power supply. Reply, 18. Further, Petitioner's implicit construction is so broad as to read any meaning out of the term "power supply", was not proposed for construction, and conflicts with Petitioner's arguments elsewhere in the Petition.

Petitioner argues that "PO's argument regarding the 'second device' coil is equally misplaced since it relies on the mistaken assumption that Logan's coils are incorporated into Birrell." Reply, 19. There are several defects with Petitioner's argument.

First, Petitioner's Demonstratives D and E (which it represents as "the Birrell-Logan combination") rely on the coils disclosed in Logan. *See, e.g.,* Pet., 16-17 ("modified with inductive coupling features formed by inductors (and related circuitry) similar to Figure 2 of *Logan*."). Petitioner cannot argue its

"Birrell-Logan combination" uses "inductors (and related circuitry) similar to Fig. 2 of Logan" and then complain that PO takes Petitioner at its word.

Second, the issue is that Logan does not disclose the use of inductors to step down voltage as implied in Demonstratives D and E. POR, 34-35. In other words, Petitioner's Demonstratives imply Logan's coils are regulating voltage similar to a transformer (as shown in Demonstratives D and E), but nothing in Logan indicates its coils are used in that manner. Logan is concerned with transferring as much power as possible across a barrier, not voltage regulation.

2. Birrell and Logan do not disclose or suggest a data receiver configured to receive data from an antenna

The Reply argues that "[t]he receiving inductor components in the modified Birrell system [that is, the coils from Logan], would have operated in similar fashion" to the claimed antenna. Reply, 19-20. But the Reply does not address PO's argument. Logan teaches using iron-core coils to transmit power wirelessly across a thick barrier. POR, 36. Birrell does not teach using coils or transmitting power wirelessly at all. Petitioner argues that "the '298 patent does not provide any limiting details concerning the claimed 'antenna'" (Reply, 20), but the claims require "a data receiver [ ] configured to receive data from an antenna." *See* Ex-1001 ['298 Patent], claims 7, 9, 10, 13, 16-18. Further, the antenna examples in the '298 Patent are used in a similar manner as described in the claims—i.e.,

converting radio waves to AC current. Ex-1001 ['298 Patent], Figs. 37, 51, 55, 20:17-22, 23:28-32, 24:31-37; Ex-2001 [Credelle Decl.], ¶115. These antenna are being used to transmit data, not power.

Petitioner argues that "inductors are used in antenna circuits" (Reply, 20), but this is irrelevant as many electrical elements may be used in antenna circuits (e.g., capacitors, resistors, diodes, etc.) that are only considered part of antennas when used in a circuit that wirelessly transmits data. Put another way, the purpose of the claimed antenna (and antennas in general) is wireless (*e.g.,* RF) data reception. The purpose of Logan's coils is to transfer power. Ex-2001 [Credelle Decl.], ¶115.

The Reply argues that PO incorrectly "suggests the claimed antenna must 'convert' RF signals." Reply, 20. But whether the antennas use RF signals or some other (undisclosed) frequency, the issue is that the claimed antennas are being used to receive data, not power. Ex-1001 ['298 Patent], Figs. 37, 51, 55, 20:17-22, 23:28-32, 24:31-37; Ex-2001 [Credelle Decl.], ¶115.

Petitioner argues that "[t]he modified Birrell system is not confined to operate at particular frequency ranges." Reply, 21. However, Birrell only discusses "data communication" using "wireless techniques" in connection with "radio frequency" and "infra-red" (which is not relevant here). Ex-1005 [Birrell], 8:14-20.

Birrell's "direct connection" embodiment—a preferred alternative to using "wireless techniques" to transmit data—is not wireless and does not discuss antennas. *Id.* The frequency ranges used in Birrell's "direct connection" embodiments are therefore not relevant to Petitioner's argument.

Similarly, Logan's coils are described as creating a "low frequency magnetic coupling" on "the order of 200 Hz." Ex-1006 [Logan], 2:1-9; *see also id.*, 2:18-26, 7:1-6, 7:20-27, 8:1-5, 8:5-12. Thus, Logan teaches its coils operate at low frequencies around 200 Hz. Accordingly, neither Birrell nor Logan support Petitioner's argument that "the modified Birrell system is not confined to operate at particular frequency ranges" for wireless transmissions. Reply, 21.

III. GROUND 3: CLAIMS 3, 10-12, AND 21 ARE PATENTABLE OVER BIRRELL, LOGAN AND ZHANG

A. Claim 3 Is Patentable Over Birrell, Logan, and Zhang

The Reply argues that there are "two ways the Birrell-Logan-Zhang combination discloses and/or suggests the limitations of claim 3." Reply, 23-24. For the "first way," the Reply appears to concedes that none of Birrell, Logan or Zhang disclose a "second device [ ] adapted to receive power from a power supply connected to an AC mains." Reply, 24 ("a POSITA would have been motivated to configure the [Birrell-Logan-Zhang] system to use AC mains"). But the Petition argued that Zhang taught this limitation. Pet., 49 ("*Zhang* discloses that the 9V AC

is derived from the 120V AC"). Accordingly, this is a *new argument* that was not present in the Petition and should therefore be disregarded. Further, Petitioner's new position relies on common knowledge of a POSITA rather than the asserted prior art references to satisfy this limitation and does not satisfy the *Arendi* standard as discussed above. Finally, Petitioner provides no analysis of why a POSITA would understand to convert the 60 Hz frequency of AC mains to the 80kHz frequency of Birrell.

Petitioner argues that "Birrell is not limited to the use of a 48V AC supply operating at 80 kHz." Reply, 24. However, the Petition relies on that embodiment of Birrell as the basis for its combination. Pet., 50 ("Based on the guidance by *Zhang*, a POSITA would have found it obvious to modify the *Birrell-Logan* combination to connect the 48V AC power supply."). It is too late to change the grounds stated in the Petition.

For the "second way" (incorporating a rechargeable battery into the system of Birrell), PO's arguments appear equally applicable and Petitioner does not explain why they would not be. Further, PO addresses why a POSITA would not add a battery to Birrell's lighting tile in detail for claim 10. POR, 44-46, *infra,* §III.B.

B. Claim 10 Is Patentable Over Birrell, Logan and Zhang

The Reply argues that "a POSITA would have been motivated to implement [a rechargeable battery in Birrell's light tile] even where a backup rechargeable battery would have added additional size or expense as PO alleges" but provides no support for that assertion. Reply, 26. Thus, Petitioner does not address PO's point that Birrell is teaching "lighting systems to illuminate wide areas" (Ex-1005 [Birrell], 2:5-8) such as a lighting fixture for houses or buildings, which rarely if ever have battery power. POR, 45, Ex-2001 [Credelle Decl.], ¶143. Typically, batteries are used in systems like smoke alarms where the primary goal is safety in an emergency. "Lighting systems to illuminate wide areas" do not share this goal because only a minimum amount of light (such as provided by a window or flashlight) is necessary in emergency situations. Not surprisingly, Zhang is just that—a flashlight for use for example by police in emergency situations such as traffic accidents. Ex-2022 [Zhang], ¶[0009]. Further, any battery added to Birrell's lighting tile would need to be larger and heavier than those in flashlights and would require additional circuitry in Birrell's lighting tile, requiring larger and stronger magnets and increasing the thickness and weight of Birrell's lighting tile. Ex-2001 [Credelle Decl.], ¶¶84, 143. Thus, a POSITA would not look to implement batteries in Birrell's lighting tiles.

Petitioner argues that "PO's piecemeal argument that Zhang does not teach wireless charging ignores the combined teachings/suggestions from Birrell, Logan and Zhang, and the state-of-the-art knowledge of a POSITA that frames the asserted combination." Reply, 26-27. However, Petitioner has not identified anything in Birrell, Logan or Zhang that teach wireless charging. To the extent Petitioner again relies on "state of the art" as an exception to the general rule that limitations require actual disclosure in a prior art reference, the Petition was required to explicitly make that argument and meet the standard set out in *Arendi*, which it has not attempted to do. As discussed in the POR and above, Birrell does not disclose wireless power transfer.

IV. GROUND 5: CLAIMS 6 AND 24 ARE PATENTABLE OVER BIRRELL

The Reply's arguments for Ground 5 claims 6 and 24 are the same. Reply, 27-28. Claim 24 depends from claim 6. Claim 6 requires "receiving power wirelessly." Ex-1001, ['298 Patent], Claim 6. Birrell does not teach receiving power wirelessly. POR, 49, 50.

Petitioner argues that "the capacitor elements in Birrell are physically separated and transfer power without wires." Reply, 27. But as discussed above and in the POR, *all capacitors have a similar dielectric gap to the one discussed for Birrell's capacitors*. *Supra,* §II.A, POR, 20. To the extent that the thin

dielectric gap in Birrell's capacitors—roughly the width of a human hair—is considered "wireless", every circuit utilizing a capacitor would be "wireless". *Id.* Accordingly, a POSITA would not understand capacitors to involve wireless power transmission. *Id.*

Birrell unambiguously supports PO's position. Indeed, Birrell uses the term "wireless" only once, where it specifically distinguishes between "data communication" using "wireless techniques such as radio frequency" and "direct connection such as modulation of the external power source." Ex-1005 [Birrell], 8:14-20. The primary embodiments of Birrell (such as Birrell Fig. 8) are examples of such "direct connection" configurations. Ex-1005 [Birrell], 13:10-14 ("the lighting element … may include a magnetizable layer *so as to be able to be secured to the supporting surface by receptive force*."), 18:9-12, 26:35-27:1. Thus, Birrell's capacitors are not separated but are affixed together to form a single secure capacitor. Further, Birrell's capacitors are not like Logan's coils, which are separated by a barrier of considerable thickness. The dielectric layer between capacitive plates is not a problem to be overcome, as in Logan, instead it is a design feature to allow for efficient energy distribution. Ex-1005 [Birrell], 3:17-4:1.

Petitioner cites several new exhibits (without explanation) for the proposition that a POSITA would understand Birrell "disclose[s] wireless power/data transfer similar to that known in the art for similar capacitive coupling configurations." Reply, 28. However, the most relevant source of what Birrell means *is* Birrell. The POR and Dr. Credelle explained why Birrell does not teach "receiving power wirelessly." POR, 49-50, Ex-2001 [Credelle Decl.], ¶¶76-81. Petitioner fails to address those arguments. Birrell discloses a system that does not transfer power wirelessly.

Petitioner also argues that Dr. Credelle's well-reasoned analysis "should be given little weight" because he allegedly "never considered how a POSITA would have understood what capacitive coupling meant in context of transferring power like that described in *Birrell*." Reply, 28. But the cited portion of Dr. Credelle's transcript indicates *exactly the opposite*. Ex-1119 [Credelle Tr.], 26:1-5 ("a person of skill in the art [ ] would not, in my opinion, consider a capacitor to be a wireless transmission of power from one plate to the other plate.").

Petitioner next argues "nor did PO dispute that Birrell discloses '*transmitting or receiving data signals wirelessly*.'" Reply, 28. Petitioner mischaracterizes Birrell's disclosure. As discussed above and in the POR, Birrell's single mention of "wireless" discloses transmitting data wirelessly via RF signals

(using, for example, a remote control) and then immediately distinguishes that scenario from its "direct connection" capacitor embodiments, which are not wireless. *Supra*, §II.A.

Accordingly, Birrell does not render obvious claims 6 or 24.

V. CONCLUSION

For the foregoing reasons, the claims of the '298 Patent should be affirmed.

Respectfully submitted,

/James T. Carmichael/
James T. Carmichael, Reg. No. 45,306
CARMICHAEL IP, PLLC

Date: October 25, 2022

CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMITS

This Patent Owner Sur-Reply (the "Sur-Reply") consists of 5,571 words, excluding table of contents, table of authorities, certificate of service, this certificate, or table of exhibits. The Sur-Reply complies with the type-volume limitation of 5,600 words as mandated in 37 C.F.R. § 42.24. In preparing this certificate, counsel has relied on the word count of the word-processing system used to prepare the paper (Microsoft Word).

Respectfully submitted,

/Stephen McBride/

Date: October 25, 2022

CERTIFICATE OF SERVICE

The undersigned hereby certifies that the following documents were served by electronic service, by agreement between the parties, on the date below:

PATENT OWNER'S SUR-REPLY

The names and address of the parties being served are as follows:

Naveen Modi
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Respectfully submitted,

/Stephen McBride/

____

Date: October 25, 2022

Trials@uspto.gov
571-272-7822

Paper No. 26
Entered: January 24, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS COMPANY, LTD.,
Petitioner,

v.

LYNK LABS, INC.,
Patent Owner.

IPR2021-01299 (Patent 10,506,674)
IPR2021-01300 (Patent 11,019,697)
IPR2021-01347 (Patent 10,966,298 B2)

Record of Oral Hearing
Held: December 13, 2022

Before JON B. TORNQUIST, STEPHEN E. BELISLE, and SCOTT RAEVSKY, *Administrative Patent Judges.*

with respect to Claim 3 and the AC mains, Patent Owner all but agreed that there would be AC mains in -- as described in Birrel and even Logan. And of course that's true, but again we did an obviousness position and in response to their Arendi arguments, I'll just point out again as I opened with Arendi was talking about having no evidence.

In fact, the Board cited to expert testimony in Arendi to support their position that they did, which was found to be a problem. But that testimony they cited to, the expert wasn't actually taking the positions that supported the Board. We don't have that issue here. We have tons of support about AC mains would have been used as a transformer. You saw the testimony, et cetera, so it doesn't apply.

And then I'll finish with this, Your Honor, since we have a combined transcript, you know, the cases that I referenced earlier about Apple vs. Andrea, AMC case, Anacor case, all those are relevant to their arguments with respect to, "Oh, they added these arguments to the reply. We were responding to their arguments which is entirely proper.

And last point, USB we didn't abandon it. I think it's quite clear in our papers. So with that, unless the Board has any more questions, I'll yield the rest of what's remaining of my time.

JUDGE RAEVSKY: Thank you, counsel. Seeing no questions, we will go back to Patent Owner. You have 17 minutes.

MR. MCBRIDE: Thank you, Your Honors.

MR. PALYS: Thank you.

MR. MCBRIDE: I'll address the arguments from Petitioner in order. With respect to Figure 9 and 10 of Birrel, I think Petitioner was arguing that

these are disclosing wireless embodiments, but these are just different. These are just different ways of drawing the same embodiment you're seeing in Figure 8 essentially.

As Petitioner talked about with respect to Figure 9, (indiscernible) capacitors. I mean, this is a standard capacitor somewhat. It doesn't imply anything wireless. It doesn't apply anything -- any gap or any distance that information is being transferred over. It's just a standard typical capacitor symbol. Now there are arrows pointing into it. This is -- presumably this would be hooked to the power supply, something just like a power Figure 8 where's the 48-volt AC power supply that's presumably coming into either end here of the two inputs in Figure 9. So it's just a different way of drawing the same thing that's shown in Figure 8.

The same is true with eleven. You see without even one of these -- every one of these lighting tiles marked 50 they have two little parallel lines, top and bottom in Figure 10 of Birrel. There's the lighting tile 50. There's two parallel lines at the top and bottom. These, again, are just the capacitors. So this box is essentially what's shown in Figure 9 or Figure 10 -- Figure 8. It's just a capacitor again with the .005 millimeter gap between it. It's got a dielectric there.

It's not designed -- it's specifically designed for a specific thickness to get the appropriate amount of capacitance that you're looking for the system in Birrel. It's not it's not some sort of gap you're trying to overcome and that leads into Petitioner's second argument, the thick versus thin argument. I think this idea of whether Birrel is wireless or not wireless has been with us since the position and then if Petitioner wasn't aware of it then, certainly

with the Patent Owner response it should have been.

So I don't think our arguments have really changed the Patent Owner response. If there was a claim construction to be proposed, it should have been. We're not necessarily arguing that the thickness or the thinness itself is the determining factor. The determining factor is whether you have some sort of gap you need to travel the power and here it's just a dielectric. It's just a circuit element, just like any other capacitor has. Just like any transformer doesn't necessarily, you know, have wires touching each other, but it's still just a circuit element. It's not a wireless transfer of power just because you have a transformer. You can separate coils like you have in Logan, and then maybe you have wireless transfer of power.

But in a typical transformer where you have wires wrapped around the single core and then (indiscernible) together and creating a magnetic field, nobody would consider that wireless (indiscernible) transformers (indiscernible) and the power supplies in our computers right now in the power cords. So things like that that are not wireless because they don't have copper wire. They're (indiscernible) because they don't have actual wires touching each other. And that's the point that we're trying to make with determining whether something is wireless or not.

And as we discussed, Birrel's capacitors aren't really touching each other. It's just a dielectric layer between the two. There was an argument about the transformers and what our experts said about Transformers and our expert did and I think part of this was to try to not create a claim construction issue over "transformer." He did say, "Okay. Logan, it has two coils and so we need to consider that a transformer because it's transmitting

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.,
Petitioner,

v.

LYNK LABS, INC.,
Patent Owner.

Case IPR2021-01347
U.S. Patent No. 10,966,298

**PATENT OWNER'S NOTICE
OF APPEAL OF FINAL WRITTEN DECISION**

VIA P-TACTS
Patent Trial and Appeal Board

via U.S.P.S. Priority Mail Express
Director of the United States Patent and Trademark Office
c/o Office of the General Counsel
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22324-1450

via CM/ECF
United States Court of Appeals for the Federal Circuit

INTRODUCTION

LYNK LABS, INC.'s ("Patent Owner") appeal stems from the Patent Trial and Appeal Board's Judgment Final Written Decision Determining All Challenged Claims Unpatentable *35 U.S.C. § 318(a)* entered on March 13, 2023 (Paper 27, "Final Written Decision") in the above-captioned *inter partes* review of United States Patent No. 10,966,298 ("the '298 Patent"). This notice of Patent Owner's appeal is timely filed within 63 days of the Final Written Decision. 37 C.F.R. § 90.3(a)(1).

PATENT OWNER'S APPEAL

Pursuant to 28 U.S.C. § 1295(a)(4)(A), 35 U.S.C. §§ 141-143, 37 C.F.R. §§ 90.2 – 90.3, (a)(1) and Fed. Cir. R. 15, Patent Owner hereby appeals to the United States Court of Appeals for the Federal Circuit from the Final Written Decision entered March 13, 2023 (Paper 27) in IPR2021-01347.

PATENT OWNER'S ISSUES ON APPEAL

Providing the information required by 37 C.F.R. 90.2(a)(3)(ii), Patent Owner states that the issues on appeal may include, but not limited to:

The issues on appeal may include but are not limited to: (1) the Board's finding of unpatentability of Claims 1, 3, 4, 10-15, 17, 21, and 23 under 35 U.S.C. § 103 based on Birrell and Logan; (2) the Board's finding of unpatentability of

Claim 2 under 35 U.S.C. § 103 based on Birrell, Logan and Johnson; (3) the Board's finding of unpatentability of Claims 3, 10-12, and 21 under 35 U.S.C. § 103 based on Birrell, Logan and Zhang; (4) the Board's finding of unpatentability of Claim 5 under 35 U.S.C. § 103 based on Birrell, Logan and Sembhi; (5) the Board's finding of unpatentability of Claims 6 and 24 under 35 U.S.C. § 102 based on Birrell; (6) the Board's finding of unpatentability of Claims 7, 8, and 25 under 35 U.S.C. § 103 based on Birrell, Logan and Camras; (7) the Board's finding of unpatentability of Claim 9 under 35 U.S.C. § 103 based on Birrell, Logan and Gleener; (8) the Board's finding of unpatentability of Claim 16 under 35 U.S.C. § 103 based on Birrell, Logan and Sontag; (9) the Board's finding of unpatentability of Claim 22 under 35 U.S.C. § 103 based on Birrell, Logan and Sontag; (10) any erroneous claim construction adopted and/or applied in connection with the aforementioned findings; and (11) any findings that conflict with the evidence of record and are not supported by substantial evidence.

Pursuant to 35 U.S.C. § 142 and 37 C.F.R. § 90.2, a copy of this Notice of Appeal is being filed simultaneously with the Patent Trial and Appeal Board, the Clerk's Office for the United States Court of Appeals for the Federal Circuit (along with the required docketing fees), and the Director of the Patent and Trademark Office c/o the Office of the General Counsel at the below-identified address.

Respectfully submitted,

_/Stephen McBride/____________________
Stephen McBride, Reg. No. 78,396
CARMICHAEL IP, PLLC
8607 Westwood Center Drive, Suite 270
Tysons, VA 22182
(703) 646-9248

Date: May 12, 2023

Case IPR2021-01347
Patent 10,966,298

CERTIFICATION OF FILING

The undersigned hereby certifies that, in addition to being electronically filed through P-TACTS, a true and correct copy of **PATENT OWNER'S NOTICE OF APPEAL OF FINAL WRITTEN DECISION** is being filed by U.S.P.S. Priority Mail Express® with the Director on the date below at the following address:

Director of the United States Patent and Trademark Office
c/o Office of the General Counsel
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22314-1450

The undersigned also hereby certifies that a true and correct copy of **PATENT OWNER'S NOTICE OF APPEAL OF FINAL WRITTEN DECISION** and the filing fee is being filed via CM/ECF with the Clerk's Office of the United States Court of Appeals for the Federal Circuit on the date below.

Respectfully submitted,

/Stephen McBride/
Stephen McBride, Reg. No. 78,396
Carmichael IP, PLLC
8607 Westwood Center Drive, Suite 270
Tysons, VA 22182
Attorney for Patent Owner

Date: May 12, 2023

CERTIFICATE OF SERVICE

The undersigned hereby certifies that the foregoing PATENT OWNER'S NOTICE OF APPEAL OF FINAL WRITTEN DECISION was served by filing this document through P-TACTS, as well as by email on May 12, 2023, on the following counsel of record for Petitioner:

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Respectfully submitted,

/Stephen McBride/

Date: May 12, 2023

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

SAMSUNG ELECTRONICS CO., LTD.
Petitioner

v.

LYNK LABS INC
Patent Owner

Patent No. 10,966,298

**DECLARATION OF R. JACOB BAKER, PH.D., P.E.
IN SUPPORT OF PETITION FOR *INTER PARTES* REVIEW
OF U.S. PATENT NO. 10,966,298**

TABLE OF CONTENTS

I, R. Jacob Baker, Ph.D., P.E., declare as follows:

I. INTRODUCTION

1. I have been retained by Samsung Electronics Co., Ltd. ("Petitioner") as an independent expert consultant in this proceeding before the United States Patent and Trademark Office ("PTO") against Lynk Labs, Inc. ("Patent Owner") regarding U.S. Patent No. 10,966,298 ("the '298 patent") (Ex. 1001).[1] I have been asked to consider whether certain references disclose or suggest the features recited in claims 1-25 ("the challenged claims") of the '298 patent. My opinions are set forth below.

2. I am being compensated at a rate of $655/hour for my work in this proceeding. My compensation is in no way contingent on the nature of my findings, the presentation of my findings in testimony, or the outcome of this or any other proceeding. I have no other interest in this proceeding.

II. BACKGROUND AND QUALIFICATIONS

3. I presently serve as a Professor of Electrical and Computer Engineering at the University of Nevada, Las Vegas (UNLV). All of my opinions stated in this declaration are based on my own personal knowledge and professional judgment. In forming my opinions, I have relied on my knowledge and experience in designing,

[1] Where appropriate, I refer to exhibits that I understand are to be attached to the petition for *Inter Partes* Review of the '298 patent.

developing, researching, and teaching regarding circuit design and light emitting diodes (LEDs) referenced in this declaration.

4. I am over 18 years of age and, if I am called upon to do so, I would be competent to testify as to the matters set forth herein. I understand that a copy of my current curriculum vitae, which details my education and professional and academic experience, is being submitted by Petitioner as Exhibit 1003. The following provides an overview of some of my experience that is relevant to the matters set forth in this declaration.

5. I have been teaching electrical engineering at UNLV since 2012. Prior to this position, I was a Professor of Electrical and Computer Engineering at Boise State University from 2000. Prior to my position at Boise State University, I was an Associate Professor of Electrical Engineering between 1998 and 2000 and Assistant Professor of Electrical Engineering between 1993 and 1998 at the University of Idaho. I have been teaching electrical engineering since 1991.

6. I received my Ph.D. in Electrical Engineering from the University of Nevada, Reno in 1993. I also received a MS and BS in Electrical Engineering from UNLV in 1988 and 1986, respectively.

7. As described in my CV, I am a licensed Professional Engineer and have more than 35 years of industry and academic experience, including extensive experience in circuit design, including design and implementation of circuit

components such as light emitting diodes (LEDs). For example, I have used LEDs in equipment for indicators, worked on the design of organic LED display electronics, used LEDs in my research in range finders as an optical source, taught using LEDs in optical communications, and used LEDs in several projects involving sensors.

8. I have taught courses in integrated circuit design (analog, digital, mixed-signal, memory circuit design, etc.), linear circuits, microelectronics, communication systems, and fiber optics. As a professor, I have been the main advisor to over 100 Master's and Doctoral students.

9. I am the author of several books covering the area of integrated circuit design including: DRAM Circuit Design: Fundamental and High-Speed Topics (two editions), CMOS Circuit Design, Layout, and Simulation (four editions), and CMOS Mixed-Signal Circuit Design (two editions). I have authored, and coauthored, more than 100 papers and presentations in the areas of solid-state circuit design, and I am the named inventor on 152 granted U.S. patents in integrated circuit designs.

10. I have received numerous awards for my work, including the Frederick Emmons Terman (the "Father of Silicon Valley") Award. The Terman Award is bestowed annually upon an outstanding young electrical/computer engineering educator in recognition of the educator's contributions to the profession.

11. I am a Fellow of the IEEE for contributions to memory circuit design. I have also received the IEEE Circuits and Systems Education Award (2011).

12. I have received the President's Research and Scholarship Award (2005), Honored Faculty Member recognition (2003), and Outstanding Department of Electrical Engineering Faculty recognition (2001), all from Boise State University. I have also received the Tau Beta Pi Outstanding Electrical and Computer Engineering Professor award the four years I have been at UNLV.

13. I am not an attorney and offer no legal opinions, but in the course of my work, I have had experience studying and analyzing patents and patent claims from the perspective of a person skilled in the art.

III. MATERIALS REVIEWED

14. The opinions contained in this Declaration are based on the documents I reviewed, my professional judgment, as well as my education, experience, and knowledge regarding electrical engineering, circuit design, and electrical devices such as light emitting diodes (LEDs).

15. In forming my opinions expressed in this Declaration, I reviewed the following materials and information:

Ex. 1001	U.S. Patent No. 10,966,298
Ex. 1004	Prosecution History of U.S. Patent No. 10,966,298
Ex. 1005	Australian Patent Application Publication No. AU2003100206 ("*Birrell*")
Ex. 1006	GB Patent Application Publication No. 2202414 ("*Logan*")
Ex. 1007	U.S. Patent No. 5,028,859 ("*Johnson*")
Ex. 1008	U.S. Patent Application Publication No. 2002/0060530 ("*Sembhi*")
Ex. 1009	U.S. Patent Application Publication No. 2002/0030194 ("*Camras*")
Ex. 1010	U.S. Patent Application Publication No. 2002/0175870 ("*Gleener*")
Ex. 1011	U.S. Patent No. 6,882,128 ("*Rahmel*")
Ex. 1012	U.S. Patent No. 4,654,880 ("*Sontag*")
Ex. 1013	S. Gibilisco, *Handbook of Radio & Wireless Technology*

Ex. 1014	U.S. Patent No. 5,657,054 ("*Files*")
Ex. 1015	RESERVED
Ex. 1016	U.S. Patent No. 6,362,789 ("*Trumbull*")
Ex. 1017	U.S. Patent No. 4,691,341 ("*Knoble*")
Ex. 1018	U.S. Patent No. 7,271,568 ("*Purdy*")
Ex. 1019	U.S. Patent No. 4,563,592 ("*Yuhasz*")
Ex. 1020	U.S. Patent Application Publication No. 2002/0149572 ("*Schulz*")
Ex. 1021	U.S. Patent No. 5,790,106 ("*Hirano*")
Ex. 1022	U.S. Patent Application Publication No. 2002/0021573 ("*Zhang*")
Ex. 1023	U.S. Patent No. 5,529,263 ("*Santana*")
Ex. 1024	U.S. Patent No. 6,879,497 ("*Hua*")
Ex. 1025	U.S. Patent No. 6,300,748 ("*Miller*")
Ex. 1026	Watson, J., Mastering Electronics, Third Ed., McGraw-Hill, Inc. (1990)
Ex. 1027	Sedra, A., *et al.*, Microelectronic Circuits, Fourth Ed., Oxford University Press (1998)
Ex. 1028	U.S. Patent Application Publication No. 2002/0158590 ("*Saito-590*")
Ex. 1029	U.S. Patent No. 4,816,698 ("*Hook*")
Ex. 1030	U.S. Patent Application Publication No. 2003/0137258 ("*Piepgras*")
Ex. 1031	U.S. Patent No. RE 33,285 ("*Kunen*")

Ex. 1040	U.S. Patent No. 10,687,400
Ex. 1041	U.S. Patent No. 10,750,583
Ex. 1042	U.S. Patent No. 10,575,376
Ex. 1043	U.S. Patent No. 10,492,252
Ex. 1044	U.S. Patent No. 10,492,251
Ex. 1045	U.S. Patent No. 10,091,842
Ex. 1046	U.S. Patent No. 9,615,420
Ex. 1047	U.S. Patent No. 9,198,237
Ex. 1048	WO2011143510 (Application No. PCT/US2011/036359)
Ex. 1049	WO2011082168 (Application No. PCT/US2010/062235)
Ex. 1050	U.S. Patent No. 8,179,055
Ex. 1051	U.S. Patent No. 8,148,905
Ex. 1052	U.S. Patent No. 7,489,086
Ex. 1053	WO2010138211 (Application No. PCT/US2010/001597)
Ex. 1054	WO2010126601 (Application No. PCT/US2010/001269)
Ex. 1055	U.S. Provisional Application No. 61/333,963
Ex. 1056	U.S. Provisional Application No. 61/284,927
Ex. 1057	U.S. Provisional Application No. 61/335,069
Ex. 1058	U.S. Provisional Application No. 60/997,771

Ex. 1059	U.S. Provisional Application No. 60/547,653
Ex. 1060	U.S. Provisional Application No. 60/559,867
Ex. 1061	U.S. Provisional Application No. 61/217,215
Ex. 1062	U.S. Provisional Application No. 61/215,144
Ex. 1080	U.S. Patent No. 6,879,319 ("*Cok*")
Ex. 1081	U.S. Patent No. 7,226,442 ("*Sheppard*")
Ex. 1082	U.S. Patent No. 6,936,936 ("*Fischer*")
Ex. 1083	U.S. Patent No. 6,078,148 ("*Hochstein*")
Ex. 1084	U.S. Patent Application Publication No. 2002/0081982 ("*Schwartz*")
Ex. 1085	U.S. Patent No. 4,350,973 ("*Petryk*")
Ex. 1086	U.S. Patent No. 4,797,651 ("*Havel*")
Ex. 1087	U.S. Patent No. 5,324,316 ("*Schulman*")
Ex. 1089	U.S. Patent Application Publication No. 2004/0207484 ("*Forrester*")
Ex. 1091	U.S. Patent Application Publication No. 2003/0122502 ("*Clauberg*")
Ex. 1092	U.S. Patent Application Publication No. 2005/0128751 ("*Roberge*")
Ex. 1093	U.S. Patent Application Publication No. 2002/0195968 ("*Sanford*")

Ex. 1094	WO 03/009535 A1 (Application No. PCT/JP020/07198) (Japanese original and English translation, including translator's certification) ("*Oba*")[2]
Ex. 1095	Universal Serial Bus Specification Revision 2.0, April 27, 2000
Ex. 1096	U.S. Patent No. 5,293,494 ("*Saito*")
Ex. 1097	U.S. Patent No. 6,814,642 ("*Siwinski*")
Ex. 1098	U.S. Patent Application Publication No. 2003/0076306 ("*Zadesky*")
Ex. 1099	U.S. Patent Application Publication No. 2003/0231168 ("*Bell*")
Ex. 1100	U.S. Patent No. 6,907,089 ("*Jensen*")
Ex. 1101	U.S. Patent No. 5,532,641 ("*Balasubramanian*")
Ex. 1102	U.S. Patent Application Publication No. 2003/0146897 ("*Hunter*")
Ex. 1103	U.S. Patent No. 6,439,731 ("*Johnson-731*")
Ex. 1104	U.S. Patent No. 7,348,957 ("*Cui*")
Ex. 1105	U.S. Patent No. 4,573,766 ("*Bournay*")
Ex. 1106	U.S. Patent Application Publication No. 2002/0191029 ("*Gillespie*")
Ex. 1112	U.S. Patent No. 8,055,310 (*Beart*)

[2] References to Ex. 1094 are to English translation document page:line numbers.

16. I also reviewed any other materials I refer to in this Declaration in support of my opinions.

17. My opinions contained in this declaration are based on the documents I reviewed and my knowledge and professional judgment. My opinions have also been guided by my appreciation of how a person of ordinary skill in the art would have understood the state of the art, the prior art, and the claims and the specification of the '298 patent at the time of the alleged invention.

18. I have been asked to initially consider that the time of the alleged invention of the '298 patent is around February 25, 2004, the earliest date of one of the provisional applications, U.S. Provisional Application No. 60/547,653, which I understand is a provisional application of the '298 patent. ('298 patent at cover). My opinions reflect how one of ordinary skill in the art (which I described below) would have understood the '298 patent, the prior art to the patent, and the state of the art at the time of the alleged invention as I was asked to consider noted above.

19. Based on my experience and expertise, it is my opinion that the prior art discloses or suggests all the features recited in challenged claims 1-25 of the '298 patent, as I discuss in detail below.

IV. PERSON OF ORDINARY SKILL IN THE ART AND THE TIME OF THE ALLEGED INVENTION

20. Based on my knowledge and experience, I understand what a person of ordinary skill in the art would have known at the time of the alleged invention, which I discussed above as being around February 25, 2004. My opinions herein are, where appropriate, based on my understandings as to a person of ordinary skill in the art at that time. In my opinion, based on the materials and information I have reviewed, and based on my experience in the technical areas relevant to the ’298 patent, a person of ordinary skill in the art at the time of the alleged invention of the ’298 patent would have had at least a bachelor’s degree in electrical engineering, computer engineering, computer science, physics, or the equivalent, and two or more years of experience with LED devices and/or related circuit design, or a related field. More education can supplement practical experience and vice versa. I apply this understanding in my analysis herein.

21. All of my opinions in this declaration are from the perspective of one of ordinary skill in the art, during the relevant timeframe (e.g., the time of the alleged invention), which I discussed above as being around February 25, 2004. My opinions in this declaration are also applicable from the perspective of such a skilled person at other related time frames (e.g., 2003 to 2005 time frames), and thus to the

extent the time of the alleged invention was determined to be in such time frames, my opinions in this declaration would not change.

V. TECHNICAL BACKGROUND

22. As I discuss further below in Section VI, the '298 patent describes (and claims) compilations of various types of circuits and components. (*See* my discussion below in Section VI.) However, as I explain below, such circuits and components, and related technologies, were conventional and known to persons of ordinary skill in the art at the time before 2004.

23. Below, I present a brief overview of certain aspects of circuits and circuit components, like those discussed and claimed in the '298 patent, including light emitting diodes (LEDs) and other electrical devices, that were known to a person of ordinary skill in the art prior to and at the time of the alleged invention of the '298 patent (*see* above at Section IV). The features, functionalities, and concepts I describe below in this technical background section reflect the state of the art that a person of ordinary skill in the art would have had knowledge of and understood prior to and at the time of the alleged invention of the '298 patent. I rely on, and incorporate as applicable (even if not expressly mentioned below in Section IX), the following disclosures and opinions to support my opinions in this Declaration, including those opinions relating to how the prior art discloses and/or suggests the challenged claims of the '298 patent and how and why a person of ordinary skill in the art would have been motivated to consider and combine the disclosures and suggestions from one or more prior art references as I explain below in Section IX.

The concepts below would have been within the knowledge and mindset of a person of ordinary skill in the art at the time.

A. Electronic Circuits and Components

24. It was well known to a person of ordinary skill in the art prior to the alleged invention date that matter is made up of atoms, which include electrons orbiting a nucleus. (Ex. 1026, 7.) Free electrons, which are electrons that are not bound to any nucleus, are contained in large numbers in materials called conductors (e.g., metals such as copper), which conduct the flow of electrons in a uniform direction (this flow of electrons is called current, and is expressed in units of amperes). (*Id.*, 8-10.) On the other hand, "[m]aterials that are classed as insulators contain only a very few free electrons" and do not conduct current well. (*Id.*, 8.) It was well known in electrical engineering that current is at the heart of virtually all electrical principles and technologies.

25. A person of ordinary skill would have known that whereas current may flow continuously in one direction through a circuit (direct current), "[c]urrent that flows first one way and then the other is called *alternating current*, and a voltage source supplying such a current is called an *alternating voltage*." (*Id.*, 12 (emphasis in original).) It was known that "[a]lternating current is used for all mains power supplies because a.c. [i.e., alternating current] permits the user of *transformers* to increase and decrease the voltage, so that the power can be transmitted from place

to place using efficient high-voltage transmission lines." (*Id.* (emphasis in original).) It was known that alternating current and alternating voltage are periodic, and "[t]he rate at which the voltage reverses is the *frequency* of the alternation." (*Id.* (emphasis in original).)

26. A person of ordinary skill would have known that "[i]n addition to measuring the current flow, we also need to measure another factor, the potential difference between two points," which "is the energy difference between" the two points. (*Id.*, 10 (emphasis in original).) The potential difference is also called voltage and is expressed in units of volts. (*Id.*, 10.)

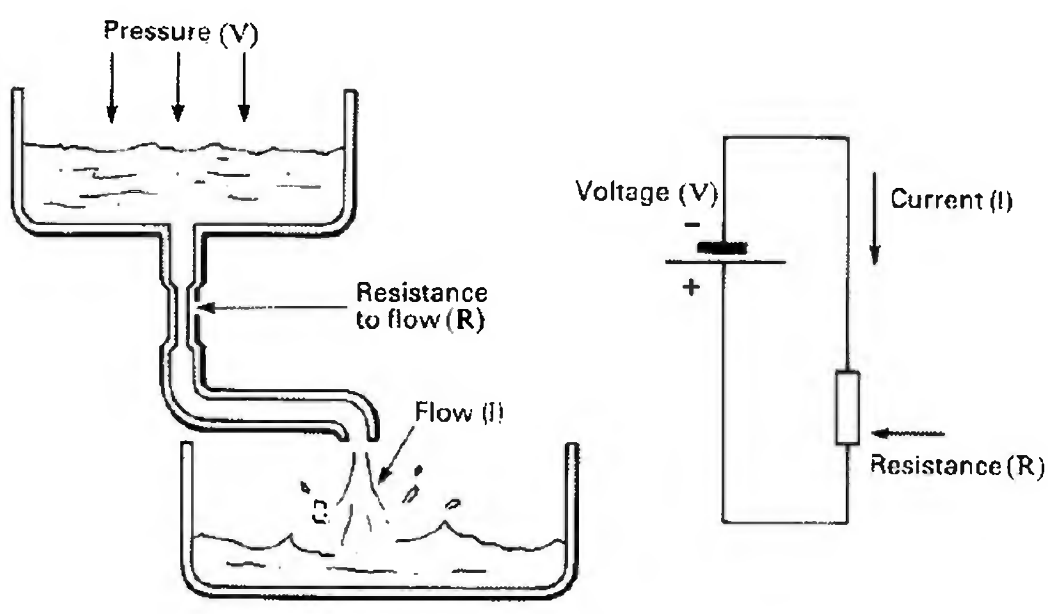
27. Additionally, a person of ordinary skill would have known that resistance is another fundamental concept involved in the flow of electrons. "Resistance is a property of all materials that reduces the flow of electricity through them," so that "[t]he higher the resistance, the more difficult it is for current to flow." (*Id.*, 10.) Resistance is expressed in units of ohms. (*Id.*, 11.)

28. A person of ordinary skill would have known that most circuit components are described as being *active* or *passive* components. (*Id.*, 19.) "Active components use the movement of electrons ... to perform some function in the circuit," whereas "[p]assive devices ... do not control the movements of the electrons, but rather allow the electrons to flow through them." (*Id.*) A person of ordinary skill would have known that the most commonly encountered passive

circuit component is the resistor, which is a "component[] intended to insert a known amount of resistance into an electrical circuit." (*Id.*)

29. The relationship between current (denoted by the letter I), voltage (denoted by the letter V), and resistance (denoted by the letter R) is given by Ohm's Law, V = I * R (i.e., voltage is current multiplied by resistance). (*Id.*, 10-11.) These three terms are shown in Figure 2.5 of *Watson* (a textbook regarding electronics), which shows how electrical principles are similar to principles relating to the flow of water.

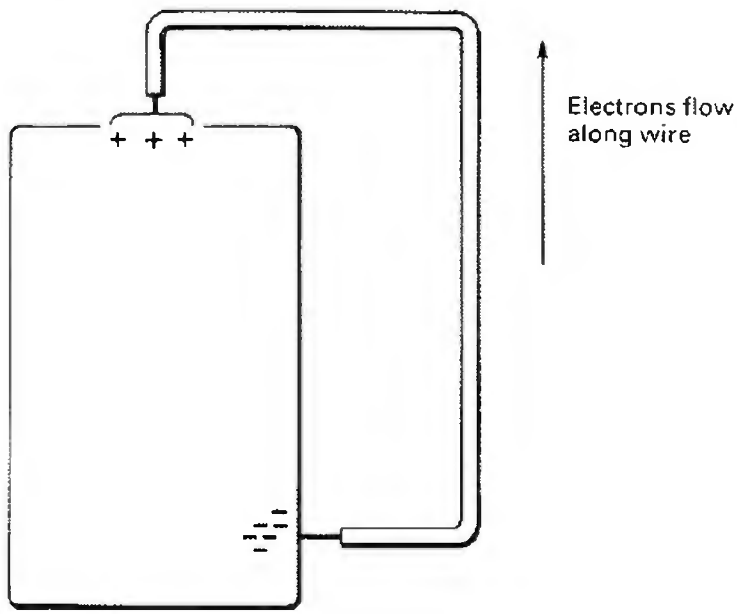
fig 2.5 ***a plumbing analogy: voltage, current and resistance all have their equivalents in the water system***



(*Id.*, FIG. 2.5.)

30. A person of ordinary skill would have known that electrons (and thus current) flow in a circuit, as shown at the right side of Figure 2.5 above, and also in Figure 2.3 below.

fig 2.3 *electrons flowing in a circuit*



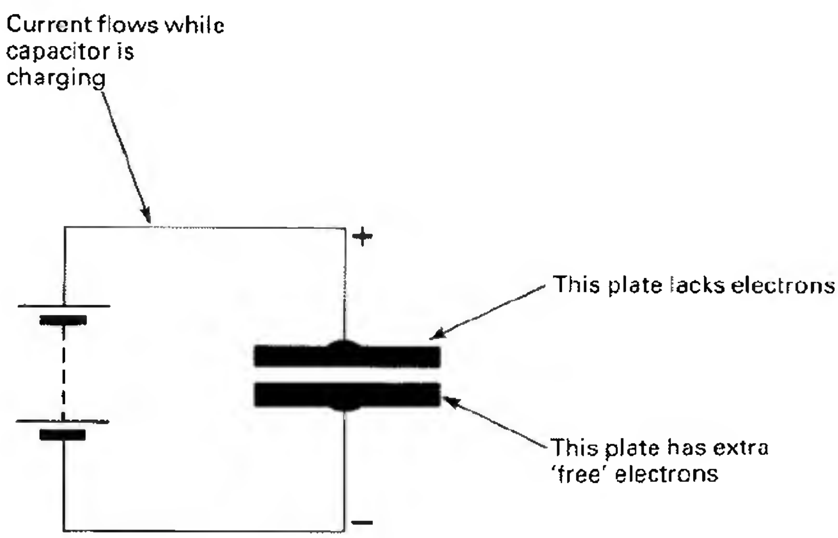
(*Id.*, FIG. 2.3.) A person of ordinary skill would have known that without such a closed path (e.g., as shown above in Figure 2.3), current cannot flow. (*Id.*, 8-11, FIGS. 2.3-2.5.)

31. It was well known that the amount of energy dissipated per unit time (power, expressed in units of watts) is expressed as the following formula: $P=VI$. (*Id.*, 19-20.)

32. A person of ordinary skill would have also known that "[n]ext to

resistors, the most commonly encountered component is the *capacitor*," which is another passive circuit component. (*Id.*, 25 (emphasis in original).) "A capacitor is a component that can store electric charge," and "[i]n essence, it consists of two flat parallel plates, very close to each other, but separated by an insulator." (*Id.*) A person of ordinary skill would have known that "[w]hen the capacitor is connected to a voltage supply, a current will flow through the circuit" as shown below in Figure 3.8 of *Watson*, and "[e]lectrons are stored in one of the plates of the capacitor" and "in the other there is a shortage of electrons." (*Id.*, 25-26.)

fig 3.8 *a capacitor connected to a power supply; current will flow until the capacitor is charged*



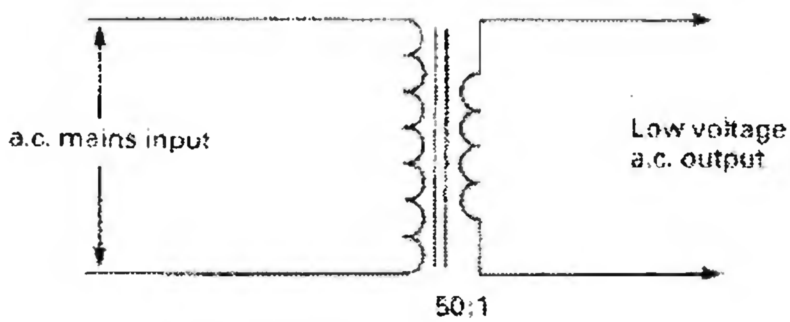
(*Id.*, FIG. 3.8.) A person of ordinary skill would have known that "[i]n this state the capacitor is said to be *charged*," and [i]f the charged capacitor is connected in a circuit, it will, for a short time, act as a voltage source, just like a battery." (*Id.*, 27

(emphasis in original).) It was known to use capacitors, such as variable capacitors that may be varied in capacitance value, in radio frequency (RF) circuits, e.g., to tune the circuit and "improve efficiency." (*Id.*, 200-201; *see also id.*, 31 (describing "[v]ariable capacitors" as "[c]apacitors ... that can be varied in value."), 201 ("the capacitors are variable, so that the circuit can be tuned accurately," i.e., "tuned to the exact frequency" for the RF transmitter to work properly).)

33. A person of ordinary skill would have known that "[t]he third major passive component is the inductor," which may be a coil of wire. (*Id.*, 33.) "When a coil is connected in a circuit ... the flow of current through the coil causes an electromagnetic field to be created around the coil." (*Id.*, 33-34.) This phenomenon was well known and commonly applied to construct a transformer, which was a known device that was widely used to reduce an AC voltage to a lower level. (*Id.*, 12; *see also id.*, 36 (FIG. 3.17, reproduced below), 37 ("A transformer is used to reduce the voltage of the a.c. mains to something more usable in electronic circuits..."), 37-41 (describing power supplies that utilize transformers and rectifiers to convert AC power to DC power).) Transformers make use of "mutual inductance," where "a current flowing in a coil produces an electromagnetic field, which in turn induces a current to flow in a second coil wound over the first one." (*Id.*, 34-35, FIG. 3.16.) It was known that by adjusting the "turn ratios" of a transformer, i.e., the ratio of the turns in the two coils of the transformer, the output

voltage of the transformer is modified. (*Id.*, 36.)

fig 3.17 ***circuit symbol for a transformer with a laminated core***



(*Id.*, 36 (FIG. 3.17, showing "circuit symbol for a transformer").)

34. A person of ordinary skill in the art would have known that in circuits, "L" signifies inductance and "C" signifies capacitance. (Ex. 1027, 884 ("The oldest technology for realizing filters makes use of inductors and capacitors, and the resulting circuits are called passive LC filters."), 909 (FIG. 11.17).)

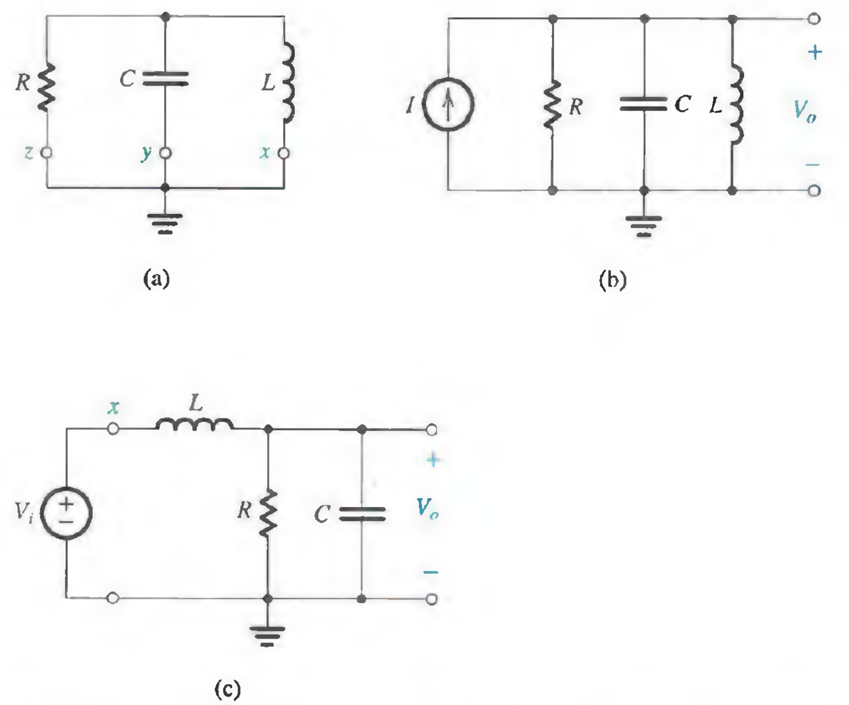


Fig. 11.17 (a) The second-order parallel LCR resonator. (b) and (c) Two ways for exciting the resonator of (a) without changing its *natural structure*. The resonator poles are the poles of V_o/I and V_o/V_i.

(*Id.*, 909 (FIG. 11.17).)

35. The use of digital logic circuitry was well known in the art, including in the context of a data receiver. (*See, e.g.*, Ex. 1085, Abstract (describing a "**receiver** apparatus" comprised of circuitry for converting "electrical signals into TTL level **digital signals,**" including an "**amplifier** for changing the electrical signal to TTL **digital logic** levels."), 2:4-8; Ex. 1086, 3:45-62 ("digital logic levels" in circuit for LED device); Ex. 1087, FIGS. 2, 4 (showing digital logic circuitry in receiver), 4:58-5:9, 6:13-32 ("clock and digital data information to logic 16"), 8:12-

42; Ex. 1081, 8:25-43 (controller of wireless device includes dedicated logic circuit), 13:14-19.)

36. It was well known to implement demodulators (including amplitude-shift-keying (ASK) and phase-shift-keying (PSK) demodulators) using digital circuitry. (Ex. 1100, 1:12-62; Ex. 1101, Abstract, FIGS. 1-5, 1:40-2:39.)

37. The use of switches in circuits was also well known. Switches were known to provide mechanisms to control signal paths according to the design and application of a circuit. There were known types of switches, which all provided similar functionalities commonly known to persons of ordinary skill in the art at the time. For instance, three-way switches were known mechanisms used in various circuit applications, such as switches for controlling circuits in residential/commercial building wiring circuits to control an electrical load from more than one location. Three-ways switches (and other types of switches) were also known to be used in other applications (e.g., digital logic or related applications). For example, three-way switches were known mechanisms to control circuits and related features, including components of portable devices. (*See, e.g.*, Ex. 1084, FIG. 15D, ¶[0075] (describing three-way switch in portable ear device); Ex. 1089, FIG. 8, ¶¶[0009], [0048] (three-way switch in wireless communication device).)

38. Transistor-transistor logic (TTL) circuitry was a well-known example

of digital logic circuit design and was applied in many implementations, including receivers. (*See also* Ex. 1085, Abstract ("**circuitry** for converting these electrical signals into **TTL** level **digital signals**" and "an amplifier for changing the electrical signal to **TTL digital logic** levels."), 2:4-8; Ex. 1086, 4:8-14 (disclosing "a **preferably TTL** … buffer 19"); Ex. 1027, 1043-1049, 1158-1159, 1167-1195.) A person of ordinary skill in the art would have appreciated that TTL circuitry was a basic design technique familiar to a person of ordinary skill in the art and a known and predictable way to implement digital logic circuitry for various applications, including in a receiver.

39. It was known to use a Universal Serial Bus (USB) port for providing power to a circuit. For example, USB connectors were known at the time to be configured to receive power and data over a conductor. (Ex. 1095, 17-18 (§§4.2.1-4.3.2), 85-91, 102; Ex. 1082, FIGS. 1-2 (element 54), FIG. 3, 1:36-40, 3:43-57 (industry standard USB port 18 providing a serial port for linking directly with "other computers and/or a means for receiving power from an external power source"), 5:56-60 (describing USB port 18 as a "serial port for linking directly with other computers to exchange data and/or to receive power" and also for receiving power from an external power source), 5:60-6:14; 6:22-27, 6:46-48, 6:62-7:2, 11:57-12:2.)

B. Diodes and LEDs

40. A person of ordinary skill would have known that a diode is a semiconductor device that allows current to "pass through it in one direction but not in the other direction." (Ex. 1026, 37.) Diodes were known for various applications, including rectifying an AC signal to produce a DC signal. For example, Figure 3.19 of *Watson* shows a half-wave rectifier implemented with a diode, and Figure 3.20 shows a full-wave rectifier using a bridge rectifier, which includes four diodes arranged as shown.

fig 3.19 ***waveforms for half-wave rectified direct current, supplied by the secondary of the transformer, through a diode***

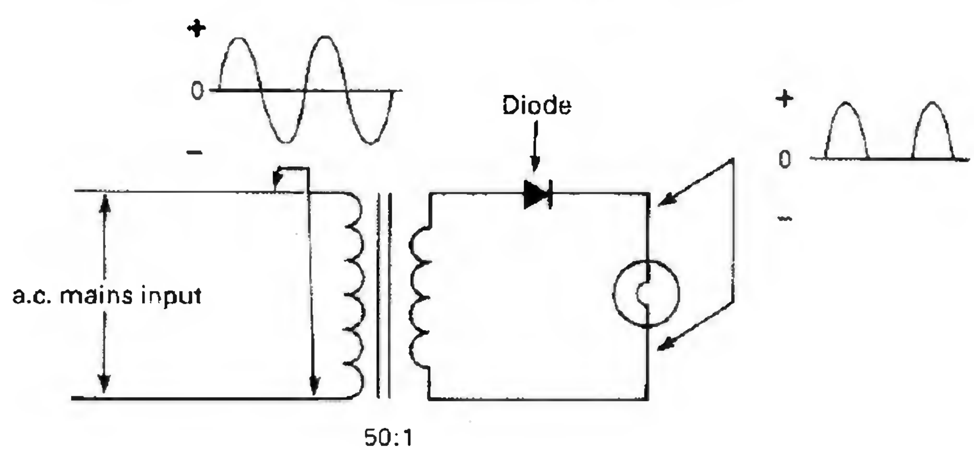
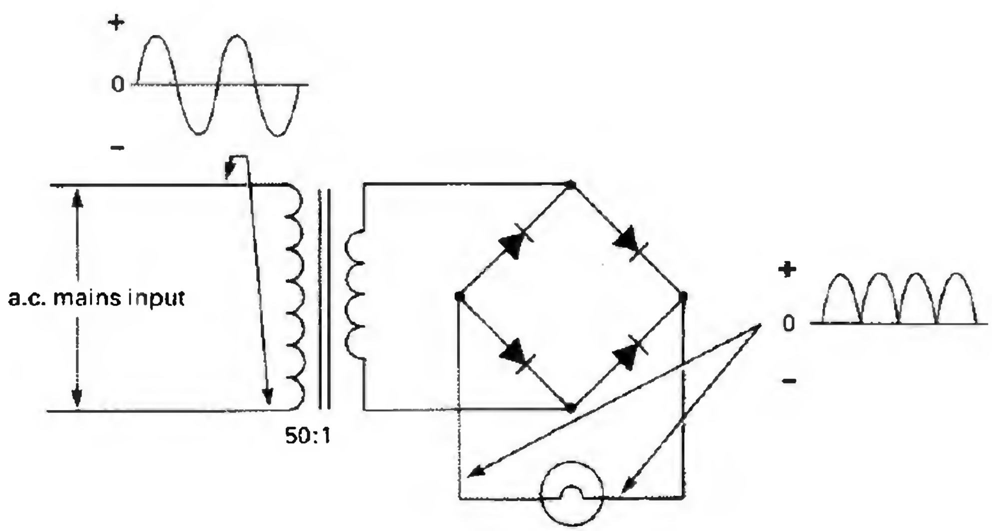


fig 3.20 *the diode 'bridge rectifier' configuration, used to provide full-wave rectification of an a.c. supply (although both halves of the a.c. input waveform pass through the lamp, the current flow through the lamp is not smooth—and this would upset the operation of many circuits)*

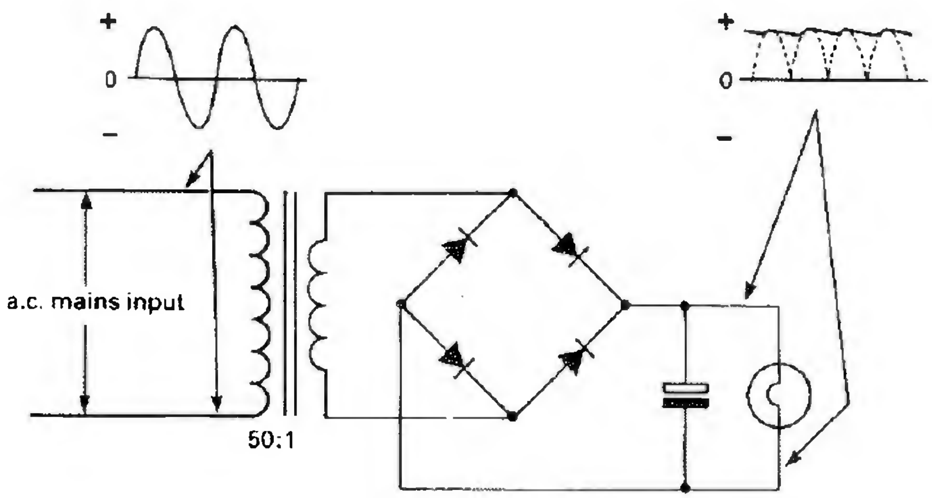


(*Id.*, 38 (FIGS. 3.19 (showing diode with circuit symbol of a triangle pointing at a vertical line), 3.20 (same, and showing diodes in bridge rectifier configuration)).)

41. A person of ordinary skill would have known that the rectified voltage signal shown at the right side of Figure 3.20 can be smoothed to a relatively constant DC voltage, using a smoothing capacitor connected in parallel with the load (e.g., a light bulb that consumes the supplied power) as shown below in Figure 3.21 of *Watson*, so that the capacitor "suppl[ies] the required current when the voltage drops during each half-cycle of the mains supply" and "[w]hen the voltage rises, the capacitor is recharged, so that it has energy available to fill in the 'gaps' in the

supply." (*Id.*, 38.)

fig 3.21 *the bridge rectifier with smoothing capacitor; a large capacitor is used to provide power during the 'gaps' in the rectified waveform*



(*Id.*, 39 (FIG. 3.21).)

42. A person of ordinary skill would have known that a light-emitting diode, or LED, is a type of diode, and it is the "simplest and most fundamental nonlinear circuit component" that "converts a forward current into light." (Ex. 1027, 122-124, 199.) As LEDs have no inherent current limiting characteristics, a resistor or other current limiting components (e.g., diodes) may be used to limit the current flowing through the LEDs. (Ex. 1026, 91; Ex. 1028, ¶[0062].) The light emitted by an LED "is proportional to the forward current in the diode" when a forward bias (a positive bias) is applied to the diode. (Ex. 1027, 124, 199; *see also* Ex. 1092, ¶¶[0241] ("Typical LED performance characteristics depend on the amount of

current drawn by the LED."), [0242]-[0243], [0254].) When a reverse-bias (a negative bias) is applied to the diode, no current flows. (Ex. 1027, 124; *see also* Ex. 1001, 2:4-8 ("LEDs are intrinsically DC devices that only pass current in one polarity and historically have been driven by DC voltage sources using resistors, current regulators and voltage regulators to limit the voltage and current delivered to the LED."); Ex. 1026, 91 ("It is clear … that LEDs are used in the forward-biased mode: indeed, they must be protected from reverse-bias as they usually have a reverse breakdown voltage of only a few volts. If breakdown occurs, the LED is destroyed.").)

43. A person of ordinary skill would have known that one type of diode is an "organic light emitting diode (OLED)," which is a diode that "may utilize any of a variety of organic materials that emit light when an electric current is applied thereto." (Ex. 1093, ¶[0005]; *see also* Ex. 1092, ¶¶[0122] ("organic LEDs, or OLEDs"), [0133] ("the term LED refers to light emitting diodes of all types (including ... organic light emitting diodes").) As shown below in Figure 2 of *Sanford*, a person of ordinary skill would have known that an OLED is commonly depicted in a circuit diagram with the same circuit symbol as a diode:

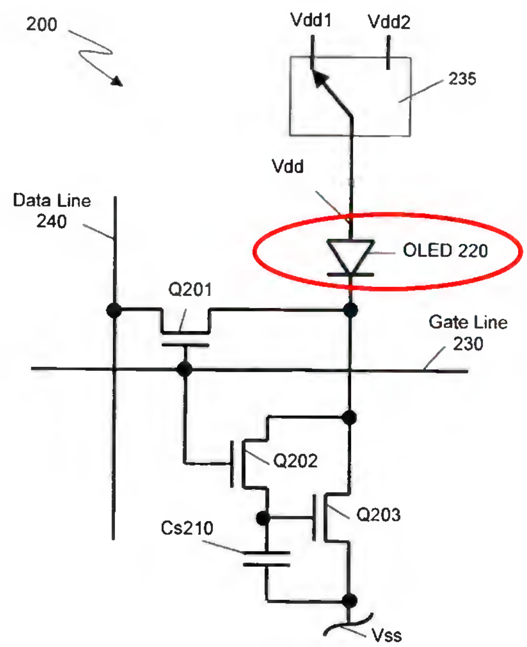


FIG. 2

(Ex. 1093, FIG. 2 (OLED 220 annotated in red).)

44. It was known to use OLEDs in, e.g., a display. For example, a person of ordinary skill would have known that "[a]n OLED display comprises a plurality of OLED pixels organized into an array." (*Id.*, ¶[0005]; *see also id.*, ¶[0006] (describing techniques of making an "OLED display").)

45. It was well known that LEDs have been commonly used in various devices and applications, including displays and lighting devices providing different colors of lights. (Ex. 1027, 199; *see also* Ex. 1001, 2:11-26 ("LED based lighting may be used for general lighting, specialty lighting, signs and decoration such as for Christmas tree lighting."); Ex. 1005, 11-12 (disclosing use of LEDs in a lighting

device); Ex. 1022, Abstract ("uses LEDs to replace the incandescent bulbs for ... lighting devices because the LED has much lower power consumption, much longer lifetime, and many other advantages than incandescent bulb"); Ex. 1026, 90 (disclosing that LEDs could be used to replace miniature incandescent lamps in a whole range of applications).) Some LEDs can produce "coherent light with a very narrow bandwidth," i.e., a laser diode, that may be used in optical communication systems and CD players, for example. (Ex. 1027, 199.) LEDs were also known to be used as a source of illumination for computer or portable computing device displays (e.g., backlit displays, OLED type displays), and as a source of lighting for indicator lamps on such computing devices. (*See e.g.,* Ex. 1094 (discussed below in Sections VIII.A and IX); Ex. 1093, ¶¶[0005]-[0006] ("OLED display"); Ex. 1102, ¶[0021] ("power consumption of each [LED] pixel of the display screen may increase as the brightness of the pixel increases"); Ex. 1103, 4:53-7:14, (LED back lighting for display); Ex. 1104, 4:40-5:55 (control power to LED backlight source for LCD display of portable computer); Ex. 1105, Abstract ("LED backlighting panel" for LCD display), 4:5-14; Ex. 1106, ¶[0038] ("organic light emitting diode (OLED) display").)

C. Power Supply for LEDs

46. As I discussed above, it was known to use a power supply to supply power to a device. Given that LEDs only conduct current in one direction, it was known to drive LEDs with a DC power supply. (Ex. 1091, ¶[0004] ("LEDs are semiconductor devices that produce light when a current is supplied to them. LEDs are intrinsically DC devices that only pass current in one polarity and historically have been driven by DC voltage sources using resistors to limit current through them.").) A person of ordinary skill would have known that in addition to being driven by DC voltage sources, LEDs can also be powered by an AC source. (*Id.*, ¶[0005] ("LEDs can be operated from an AC source if they are connected in an 'anti-parallel' configuration").)

47. It was known that because U.S. household power, like in many other parts of the world, is supplied as AC power (e.g., 120 volts AC, commonly referred to as "VAC") from the electrical grid, in order to provide DC power to LED-based devices, a rectifier "can be used to generate dc from ac." (Ex. 1027, 125-126; *see also id.*, 179, FIG. 3.36; Ex. 1001, 2:23-26 ("This type of LED light string converts input electrical power, usually assumed to be the common U.S. household power of 110 VAC, to a low voltage, rectified to nearly DC input."); Ex. 1022, ¶[0083]-[0084] ("The 120 VAC or 220 VAC power from the commercial line is reduced to 9 VAC

by the transformer 31" and the 9 VAC is converted to DC power by components such as a rectifier 35 as shown in FIG. 2.1).)Ex. 1027

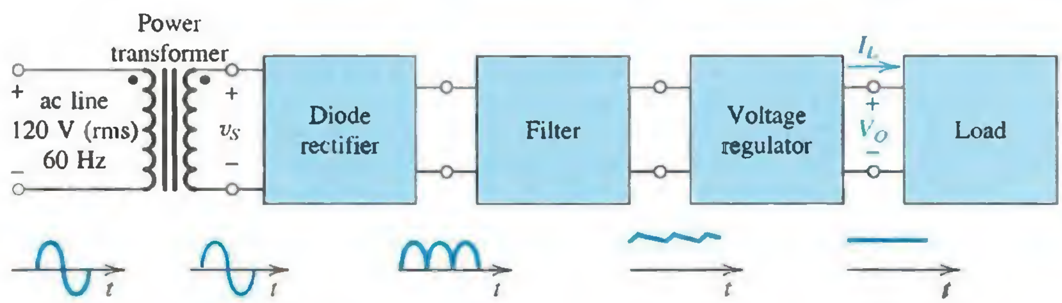


Fig. 3.36 Block diagram of a dc power supply.

(Ex. 1027, FIG. 3.36.)

48. FIG. 3.36 as shown above provides an example of a DC power supply, which includes a power transformer consisting of two coils, where the first coil (on the left side) is connected to a 120V AC power (e.g., from household wall plugs) and the second coil (on the right side) is connected to the diode rectifier. (*Id.*, 179, FIG. 3.36.) Depending on the number of turns the coils have, the AC voltage may be stepped down to a lower voltage appropriate for the DC power supply input. (*Id.*) As shown in the bottom of FIG. 3.36 (i.e., the time-dependent voltage waveforms), the rectifier converts the AC power (containing both polarity of voltages) to DC power (containing a single polarity of voltage) by chopping off, e.g., the negative portion of the AC power, such that the current flows in a single direction. (*Id.*, 179-180.) Following the rectifier, the rectified waveform is filtered and regulated to

remove unwanted pulses and ripples. (*Id.*; Ex. 1083, FIG. 1, 4:19-24 (capacitor to filter DC power).)

49. It was well known in the art that the brightness of LEDs is controlled by the amount of power provided to the LEDs and it was known that the brightness of portable computer displays could be controlled by increasing/decreasing power to back light circuitry and/or LED pixels in response to touch sensor inputs. (Ex. 1102, ¶¶[0012], [0016]-[0017], [0018]-[0020] (increasing brightness of active window), [0021] ("power consumption of each [LED] pixel of the display screen may increase as the brightness of the pixel increases"), [0022]-[0023], claims 1, 4-5, 7; Ex. 1096, FIGS. 1-2, 9A-9B, 2:27, 4:1-7, 13:63-67 (describing mechanisms in a portable computer that includes a touch panel that accepts input from a user), 6:3-11 ("back-light control circuit 308 controls the back-light power supplied to the LC display 37, or the quantity of back light"), 9:24-10:3 (turning off power), 10:3-8 ("[w]hen data is input from the keyboard 36, thereafter, the back-light lamp is turned on immediately, and thus the input operation is enabled"), 13:53-14:4 (explaining backlight power may be stopped upon lapse of a time period from "the last inputting of data from an input device other than a keyboard, such as a mouse, a touch panel, …").) It was known that brightness adjusting circuits in display devices "var[y] over a range the electrical power provided to an illumination source" and that it was "recognized by those of ordinary skill in the art" that a "brightness adjusting circuit

[] for use with [an] illumination source [] formed of LED or OLED sources is a relatively simply circuit" and that "the nature of LED and OLED sources is such that the light or radiation output is infinitely adjustable which results in a superior dimming or brightness control." (Ex. 1103, 6:9-22; *id.*, 4:41-45; *see also* Ex. 1096, 10:3-8.)

D. Touch Sensors

50. Touch sensors were known for enabling a user of an electronic device (e.g., cell phone, PDA or laptop computer) to provide input to a touch sensitive screen, without pressing a physical button. A person of ordinary skill in the art would have known that capacitive touch sensors were ideal for use in small sensing areas, and also would have known that capacitive touch sensing was a common way of implementing touch-related user input functionalities. (Ex. 1097, FIGS. 3A, 9, 1:44-50, 2:17-37, 5:53-4:4; Ex. 1098, ¶¶[0011]-[0013], FIGS. 1, 8, 9 ¶¶[0014], [0036], [0041] [0052], [0064]; Ex. 1099, ¶¶[0107], [0116], [0132] (known capacitive touch pad products); Ex. 1080, Title, Abstract, 2:42-46, 12:18-22).)

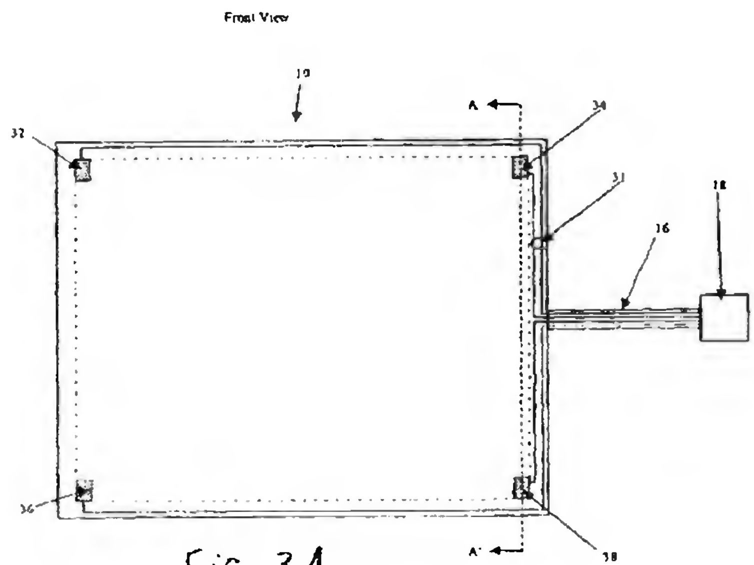


FIG. 3A
(PRIOR ART)

(Ex. 1097, FIG. 3A.) For example, in U.S. Patent No. 6,814,642 ("*Siwinski*"), "FIG. 3*a* shows a top view of a capacitive sensing touch screen 10." (*Id.*, FIG. 3A, 2:17-18.) The "touch sensitive elements 14" have a "transparent metal oxide layer 30 formed on substrate 12," with "[m]etal contacts 32, 34, 36, and 38 … located on the metal oxide layer 30 at the corners of the touch screen 10." (*Id.*, 2:19-22.) "These metal contacts are connected by circuitry 31 to conductors in cable 16." (*Id.*, 2:23-24.) The external controller 18 causes voltage to be applied to the metal contacts, which creates a "uniform electric field across the surface of the substrate 12, propagated through the transparent metal oxide layer 30." (*Id.*, 2:24-28.) When a finger touches the touch screen, "it capacitively couples with the screen causing a

minute amount of current to flow to the point of contact." (*Id.*, 2:28-31.) Because "the current flow from each corner contact is proportional to the distance from the corner to the point of contact," the controller 18 is able to "measure[] the current flow proportions and compute[] the (X, Y) coordinates of the point of touch." (*Id.*, 2:31-35.)

51. It was also known that touch pads include one or more sensors for detecting the proximity of the finger, typically arranged in grids of columns and rows representing x, y positions on the touch pad. (Ex. 1098, ¶¶[0011]-[0014].)

52. Touch sensors, such as capacitive touch sensors, were known to be implemented in LED-based devices, e.g., LED lighting devices to control the light emission from the LEDs. (Ex. 1005, 8:4-30 (disclosing a LED lighting device having "touch switches or light level controls"), 16:18-26 (disclosing a capacitive touch sensor control a LED lighting device capable of "human touch sensing"); Ex. 1029, Title ("Touch Control Circuit for Incandescent Lamps and the Like"), Abstract (disclosing "[a] touch control circuit," where "[t]ouch detector circuitry alters the power level memory so as to correspondingly alter the power delivered by the power delivery means when the touch detector is touched"), 1:6-13 (describing "electronic circuits known as touch controls for electric lamps"); Ex. 1030, Abstract (describing "[v]arious exemplary implementations of light emitting diode (LED) based illumination products and methods are disclosed…."), ¶¶[0094]-[0102] (describing

that a user interface for adjusting LED lighting may include "touch pads"); Ex. 1031, Abstract ("Each time the lamp is touched the power to the bulb increases by one step, typically in the sequence OFF, DIM, INTERMEDIATE, FULL, OFF."), 2:56-60 ("[T]ouch sensing is made possible by electrically sensing a change in capacitance fo the lamp when it is touched....").) Capacitive touch sensors have also been used to allow user input in LED-based touch pad/panel. For example, U.S. Patent No. 6,879,319 ("*Cok*") discloses "[a]n integrated OLED display and touch screen" that provides a substrate, a top-emitting OLED display on the substrate, a transparent encapsulating cover with the touch screen on the first side, light blocking circuit elements extending to the edge of the cover/substrate, and a light curable adhesive between the light blocking circuit elements of the display and the touch screen. (Ex. 1080, Abstract.) U.S. Patent No. 6,814,642 ("*Siwinski*") discloses an alternative *bottom-emitting* OLED display and touch screen structure, "where light is emitted through the substrate 50, conductors 54, and hole injection layer 56." (Ex. 1097, 3:4-7, FIG. 10 (disclosing a capacitive touch screen utilizing a bottom-emitting structure).)

E. Wireless Communication

53. A person of ordinary skill would have been well versed in techniques for wireless communication between a transmitter and a receiver. For example, *Logan* notes that "[i]t is, of course, known in principle to transmit power and data

using radio waves." (Ex. 1006, 1:10-12.) It was well known to use inductor coils to facilitate wireless signal transmission. (Ex. 1081, 5:39-66 (describing "receiv[ing] power from an electromagnetic (EM) energy source" and "a coil for the receipt of electromagnetic energy"); Ex. 1006, Abstract, FIGS. 1-2, 3:19-23, 4:12-14, 6:3-5.) It was known in the art to energize a transmitter coil using an alternating electromagnetic field to wirelessly send information to a receiver with a receiver coil. For example, *Logan* discloses features consistent with that known by a person of ordinary skill in the art regarding transmitting data wirelessly. (Ex. 1006, Title, Abstract, FIG. 2 (reproduced below).) *Logan* demonstrates it was known to use an "electromagnetic signal … of sinusoidal form" to convey power between a transmitter 24 and a receiver 22. (*Id.*, 6:12-14, FIG. 2.) Likewise, *Logan* provides guidance about "energising a transmitter coil 12 to create an alternating electromagnetic flux," which "induces an E.M.F. in a receiver coil 16" (*id.*, 3:19-23) "to [wirelessly] convey information to a demodulator in the receiver "(*id.*, 3:24-25).

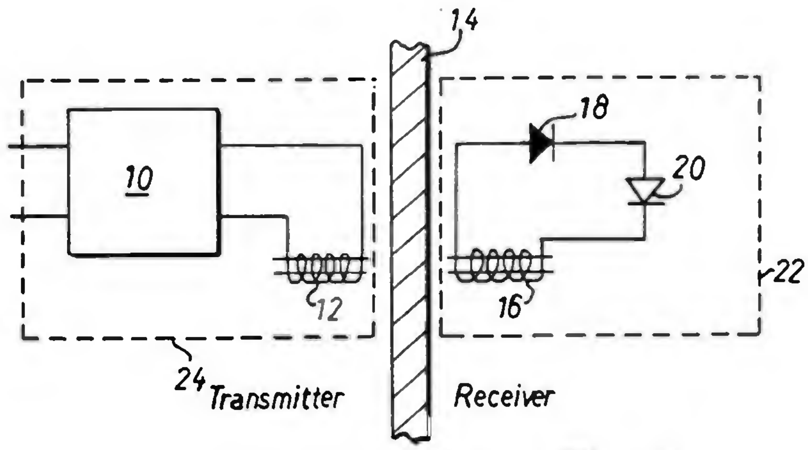


Fig 2

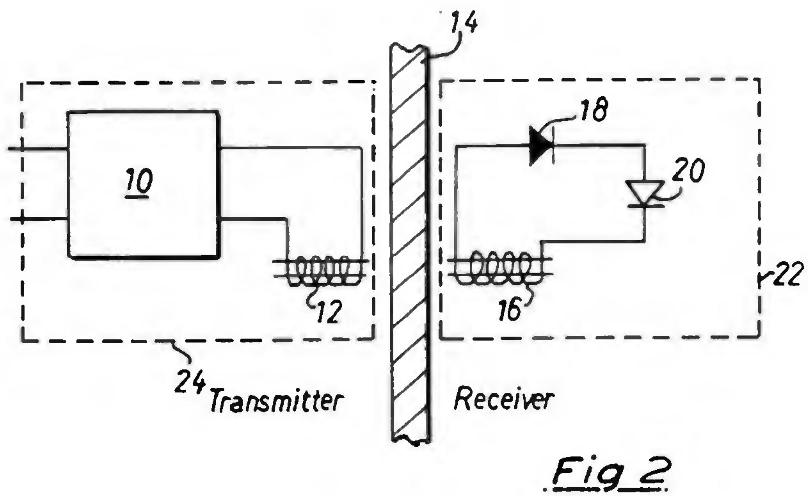
(*Id.*, FIG. 2.)

F. Wireless Power

54. It was well known to use inductor coils to facilitate wireless transmission of power. (Ex. 1081, 5:39-66 (describing "receiv[ing] power from an electromagnetic (EM) energy source" and "a coil for the receipt of electromagnetic energy"); Ex. 1006, Abstract, FIGS. 1-2, 3:19-23, 4:12-14, 6:3-5.)

55. It was known in the art to energize a transmitter coil using an alternating electromagnetic field to wirelessly send information to a receiver with a receiver coil. For example, *Logan* discloses features consistent with that known by a person of ordinary skill in the art regarding transmitting power wirelessly. (Ex. 1006, Title, Abstract, FIG. 2 (reproduced below).) *Logan* demonstrates it was known to use an "electromagnetic signal … of sinusoidal form" to convey power between a transmitter 24 and a receiver 22. (*Id.*, 6:12-14, FIG. 2.) Likewise, *Logan* provides

guidance about "energising a transmitter coil 12 to create an alternating electromagnetic flux," which "induces an E.M.F. in a receiver coil 16" (*id.*, 3:19-23) to enable "a basic sinusoidal transmitter" to wirelessly "convey power to the receiver" (*id.*, 3:24-28).



(*Id.*, FIG. 2.)

VI. THE '298 PATENT

56. While the '298 patent purports to identify an invention directed to an LED device/system having various features (*e.g.,* Ex. 1001, 4:30-11:3, 13:36-61), the claims are broadly directed to generic apparatuses and methods for operating the same that include compilations of familiar one-off components/features that provide no novel functionality to advance the art. The claims recite components like LEDs, data receiver, transmission conductor, inductor, three-way switch, AC mains, and capacitive touch detection, without offering any unique feature about their compiled existence in the alleged inventions. Unsurprisingly, all of the generically claimed features were already known in the prior art. (*See* below at Section IX; Exs. 1040-1062.)

57. As explained below, all of the recited features in the challenged claims were well-known in the art.

VII. CLAIM CONSTRUCTION

58. I understand that claim terms are typically given their ordinary and customary meanings, as would have been understood by a person of ordinary skill in the art at the time of the alleged invention, which as I explained above I have been asked to assume is around February 25, 2004. In considering the meaning of the claims, however, I understand that one must consider the language of the claims, the specification, and the prosecution history of record. I have been asked to consider

the claim terms under their plain meanings and thus considered the claims, specification and prosecution history for the '298 patent in doing so in support of my opinions concerning the '298 patent and the prior art discussed herein.

VIII. OVERVIEW OF THE PRIOR ART

A. *Birrell* (Ex. 1005)

59. I understand that AU2003100206 is an Australian Patent Application Publication. (Ex. 1005, Cover.) My understanding is that *Logan* was published July 17, 2003. (*Id.*) *Birrell* discloses "systems and methods for connecting electrical devices to power sources" (Ex. 1005, 2:3-5) and the system may be a "lighting system[] to illuminate wide areas." (*Id.*, 2:3-8.) *Birrell* explains that "the device may be coupled to the power source without requiring any direct connection." (*Id.*, 2:36-3:16, 3:17-27; *see also id.*, Abstract, 2:3-5, 16:37-18:13, FIGS. 1-3 and 8.)

60. *Birrell* discloses with reference to Figure 1 that the lighting system includes a lighting tile 50 that has multiple LEDs 59. (*Id.*, 14:26-15:33.) Lighting tile 50 also includes metalized strips 55 and 56 that "act as electrical coupling elements for the tile 50 to enable it to be capacitively coupled to a power source." (*Id.*; *see also id.*, 16:37-18:13, 17:21-28.)

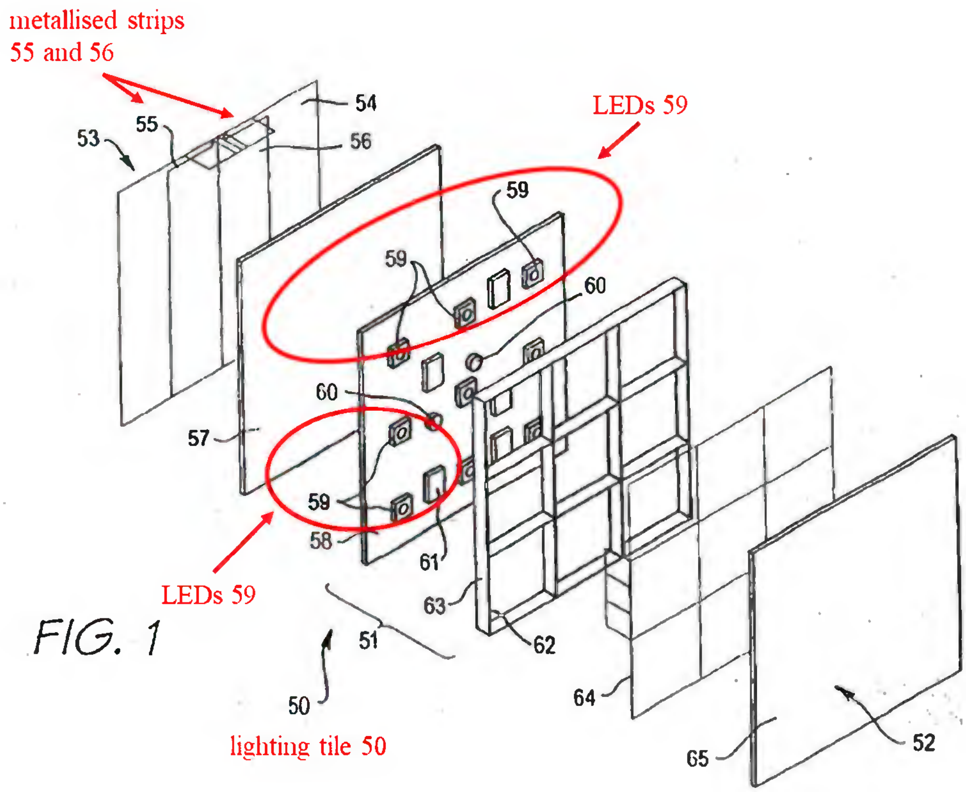


FIG. 1

(Ex. 1005, FIG. 1 (annotated to show lighting tile 50 having multiple LEDs 59 and metallised strips 55 and 56).) Lighting tile 50 additionally includes sensors 60, where "[t]he exact nature of the sensors may vary depending on the required functionality of the lighting tile 50." (*Id.*, 15:21-23.) For example, the sensors may include a capacitive touch sensor that senses human touch (*id.*, 16:18-26) and many other types of sensors:

> any one or combinations of the following: pyroelectric sensors, long wave length infrared sensors, microwave proximity sensors, ultrasonic proximity sensors, infra-red

> short wave detectors for remote control, photosensors for visible light level detections, temperature sensors, humidity sensors, air pressure sensors, smoke detectors, RF transmitter or receiver modules, microphone, video image capture, infra-red image capture, and touch sensor conditioning electronics.

(*Id.*, 15:23-33.)

61. *Birrell* discloses with reference to Figure 8 a circuit diagram of the lighting system that includes "LEDs … capacitively coupled to an AC power supply" via capacitors C_A and C_B. (*Id.*, 20:26-31; *see also id.*, 14:8-13, 21:34, 23:2-11.)

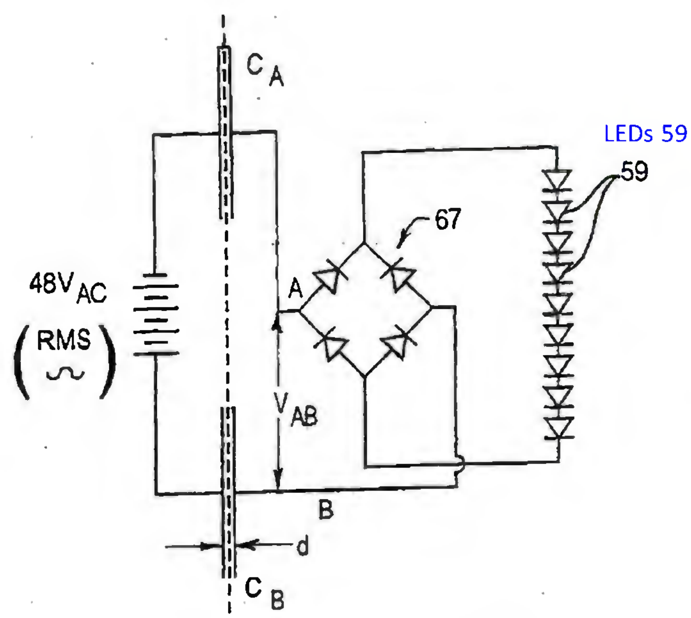


FIG 8

(Ex. 1005, FIG. 8 (annotated).) As shown in Figure 8, the nine LEDs 59 are connected to diodes 67, where diodes 67 collectively form a bridge rectifier. (*Id.*, 19:1-4.) The bridge rectifier "ensures that light is emitted from the LEDs during both the positive and negative cycles of the AC power supply." (*Id.*, 19:4-8.)

62. Additionally, *Birrell* discloses that "the light tile circuitry is structured so that all data is transferred by the same electrical path that is used for the electrical power transfer." (*Id.*, 23:15-21.)

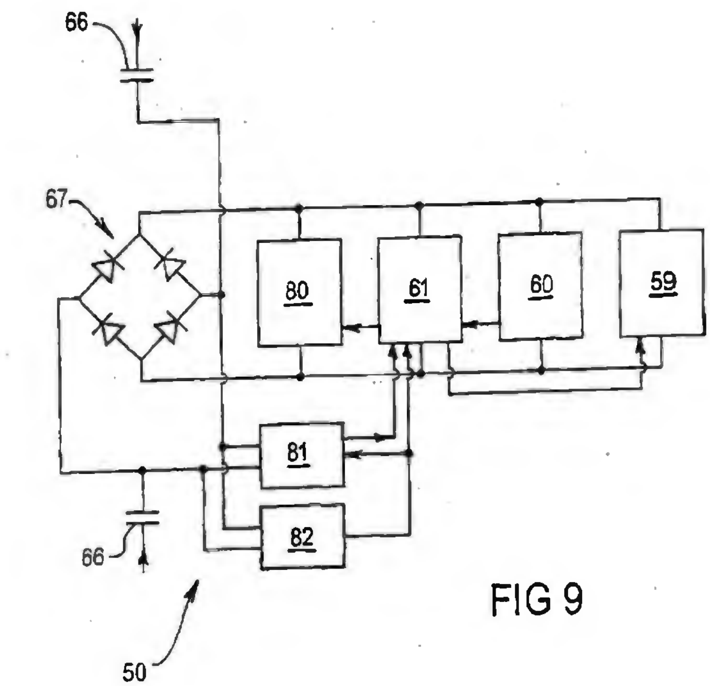


FIG 9

63. For instance, as disclosed with reference to Figure 9 of *Birrell*, each light tile 50 is capable of transmitting and receiving data over the electrical path that transfers power:

> Each light tile 50 is able to transmit data under control of the microcontroller 61 through the data modulator 80 transmitted over the electrical path and extracted on another tile or device via a data demodulator 81. A clock recovery circuitry 82 is also included within the lighting element 50 to recover a clock of identical frequency to the primary power. Systemwide synchronous data transmission is then facilitated by this clock.

(Ex. 1005, 23:22-29; *see also id.*, FIG. 9.) Additionally, the lighting system enables all data to be broadcast over the whole light tile system. (*Id.*, 24:3-4.) Certain light tiles can be "logically grouped … to allow a number of units to be controlled by a single message." (*Id.*, 24:10-12.)

B. *Logan* (Ex. 1006)

64. I understand that GB Patent Application Publication No. 2202414 is a UK Patent Application. (Ex. 1006, Cover.) My understanding is that *Logan* was published September 21, 1988. (*Id.*) *Logan* generally relates to a system in which power and data are transmitted across a panel/bulkhead 14 between a transmission coil 12 and a receiving coil 16. (Ex. 1006, Abstract, FIG. 2.)

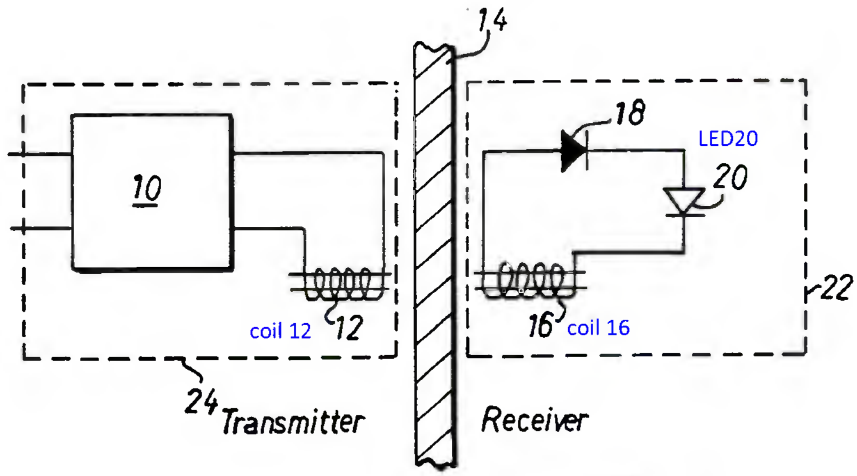


Fig 2

(Ex. 1006, FIG. 2 (annotated).) For example, the system includes a panel mounting lamp unit 22 that includes a receiving coil 16 connected in series with a diode 18 and an LED 20, where the receiving coil 16 is located at a position opposite to the transmission coil 12. (*Id.*, Abstract.) In operation, an oscillator 10 energizes the transmitter coil 12 to create an alternating electromagnetic flux, which penetrates through a panel/bulkhead 14 and induces an E.M.F. in a receiver coil 16. (*Id.*, 3:19-23.) *Logan* also discloses that data (e.g., from a computer) may be coupled to a transmitter via a modulator for reception by a receiver. (*Id.*, Abstract; *see also id.*, FIG. 5.)

65. *Logan* discloses that using inductive coupling (e.g., coils 12 and 16) to transmit wireless power (*id.*, 3:19-23) is beneficial for a lighting system that includes multiple LEDs devices that are in adjacent to each other. (*Id.*, 6:3-11.) Specifically,

Logan explains that given the "concentrated and localised nature" of the inductively generated field, LED lightings "can be densely packed without interference problems." (*Id.*; *see also id.*, 1:6-17, 1:18-24 (*Logan* "provide[s] a system…which enables large numbers of individual transmitter/receiver pairs to be positioned in relatively close proximity to each other without mutual interference between adjacent channels.").)

IX. THE PRIOR ART DISCLOSES OR SUGGESTS ALL RECITED FEATURES OF CLAIMS 1-25 OF THE '298 PATENT[3]

A. *Birrell* in view of *Logan* Discloses and/or Suggests the Features of Claims 1, 3, 4, 10-15, 17-21, and 23

66. In my opinion, *Birrell* in view of *Logan* discloses and/or suggests all of the features of claims 1, 3, 4, 10-15, 17-21, and 23 of the '298 patent.

1. Claim 1

a) An apparatus comprising:

67. I understand that this phrase is the preamble of claim 1, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitation(s) in the preamble.

68. For example, *Birrell* discloses "a system for connecting an electrical device to a power source," where "the device may be coupled to the power source without requiring any direct connection," e.g., a wireless lighting system ("apparatus"). (Ex. 1005, 2:36-3:16, 3:17-27; *see also id.*, Abstract, 2:3-5 ("systems

[3] In this section (Section IX), I refer to exhibits other than those identified prior art reference(s) that disclose and/or suggest the claimed limitations. Such exhibits reflect the state of the art known to a person of ordinary skill in the art at the time of the alleged invention.

and methods for connecting electrical device to power sources"), 16:37-18:13, FIGS. 1-3 and 8.)

69. Specifically, *Birrell*'s system includes a lighting tile 50 having LEDs 59. (*Id.*, 14:26-15:33.) Lighting tile 50 includes metalized strips 55 and 56 that "act as electrical coupling elements for the tile 50 to enable it to be capacitively coupled to a power source," facilitating wireless power transfer. (*Id.*; *see also id.*, 16:37-18:13, 17:21-28.)

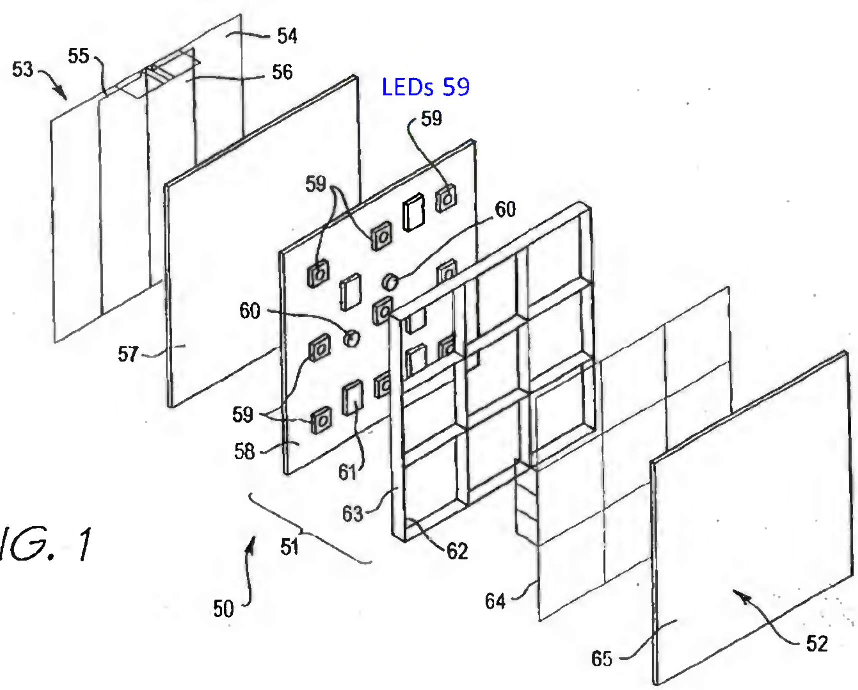


FIG. 1

(Ex. 1005, FIG. 1 (annotated).)

70. *Birrell* discloses with reference to Figure 8 a circuit diagram of the lighting system that includes "LEDs … capacitively coupled to an AC power

supply" via capacitors C_A and C_B. (*Id.*, FIG. 8 (annotated below), 20:26-31; *see also id.*, 14:8-13, 21:34, 23:2-11.)

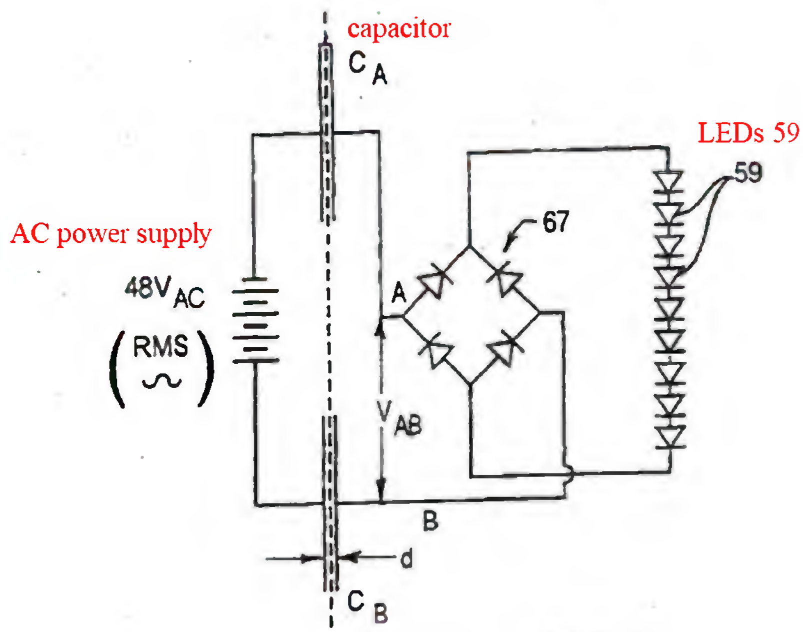


FIG 8

(Ex. 1005, FIG. 8 (annotated to show LEDs 59 capacitively coupled to an AC power supply); *see also* below at Sections IX.A.1(b)-(c) regarding the remaining elements of this claim.)

b) a first device including a first circuit having a first transmission conductor and a first inductor, wherein said first circuit is configured to use at least the first inductor to transmit power from the first device wirelessly; and

71. *Birrell* in view of *Logan* discloses and/or suggests this limitation. *Birrell*'s lighting system includes a first device that includes a circuit comprising a

conductive wire that connects to an AC power supply and to capacitors, whereby the power supply transmits wireless power to lighting tile 50's LEDs 59 through circuit 67. (Ex. 1005, 20:26-31; 21:34, 22:29-30, 23:2-11; *see also id.*, 3:17-27 ("device may be coupled to the power source without requiring any direct connection").) For example, as shown in Figures 3 and 8, and as a person of ordinary skill in the art would have understood, a conductor (e.g., an electrically conductive wire) connects the AC power supply to capacitor C_A and another conductor connects the AC power supply to capacitor C_B in order to transmit the AC power that is wirelessly sent to tile 50 having LEDs 59. (Ex. 1005, FIG. 8 (annotated below), 17:25-28 (describing with reference to Figure 3 that "each of the metallised strips is connected to the power supply"); *see also id.*, FIG. 3 (below).)

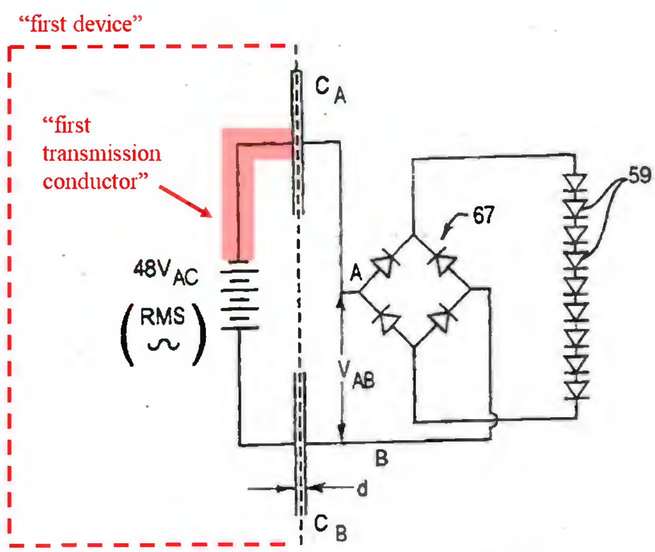


FIG 8

(Ex. 1005, FIG. 8 (annotated to show the "first device" and "first transmission conductor").)

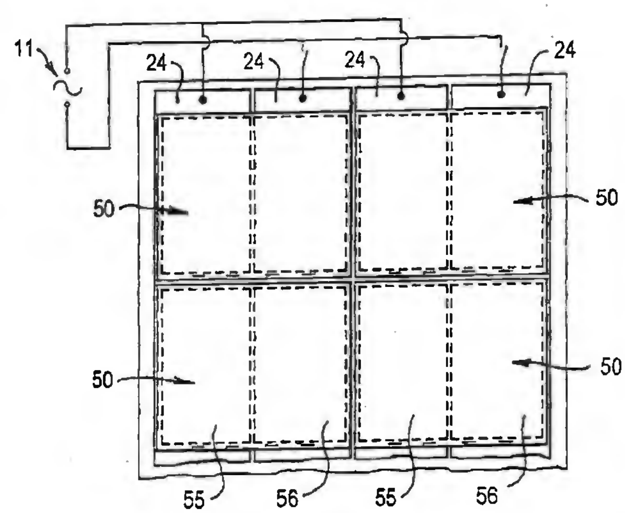


FIG 3

(Ex. 1005, FIG. 3.)

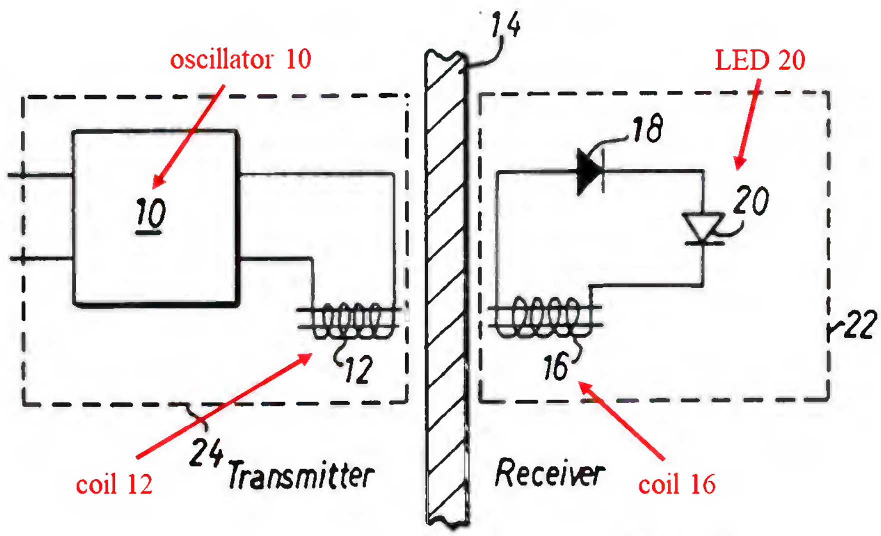
72. *Birrell* explains that tile 50's "metallised strips" 55 and 56 are capacitively coupled to "metallised strips" 24 that are connected to the power supply via the conductors on the other circuit (left side of FIG. 8's dashed line), where strips 55/56 and strips 24 are separated by an insulator. (Ex. 1005, Abstract ("The electrical device includes electrical couplings 55,56 in the form of metallised strips which are operative to form a capacitive coupling with respective conductive elements 24," which "are connected to the power supply."), FIGS. 2-3, 17:4-17:36 (disclosing with reference to FIGS. 2-3 that "the metallised strips act as electrical

coupling elements which form part of the capacitive coupling arrangement" and that "[i]nsulating layers" are provided for the metal strips), 17:37-18:12 (disclosing that strips 55/56 of lighting tile 50 "are aligned with" strips 24 such that "capacitors … are formed between the aligned pairs of strips which serve to couple the lighting elements to the power supply").) Thus, as shown in Figure 8, and as a person of ordinary skill in the art would have understood, an insulator (indicated as the dotted line in Figure 8) separates strips 55/56 of tile 50 from strips 24, which are part of the other circuit connected to the 48V AC power supply, where each of capacitors C_A and C_B are formed by a combination of strips 55/56, the insulator, and strips 24. (*Id.*, 18:6-12, 20:26-31, 21:34, 22:29-30, 23:2-11.) Furthermore, such a skilled person would have understood that the conductors connecting the power supply to capacitors C_A and C_B, and the strips that form a part of capacitors C_A and C_B, constitute a circuit because electric current flows through these circuit components consistent with the disclosed operations of the system in *Birrell*. (Section V.A.) Thus, in my opinion, *Birrell* discloses a "first device including a [first] circuit" having "a first transmission conductor" and that "the [first] circuit" is configured to wirelessly transmit power from the [first] device.

73. While *Birrell* does not expressly describe a first inductor used to wirelessly transmit power from the above described first device, a person of ordinary skill in the art would have been motivated to modify *Birrell* in view of *Logan* to

implement such features. Like *Birrell*, *Logan* discloses providing wireless power to an LED, including "across a panel/bulkhead" or a "wall." (Ex. 1006, Abstract, 1:3-2:6, 3:19-5:4, FIGS. 1-2.) As such, a person of ordinary skill in the art would have had reason to consider *Logan* when contemplating/implementing the system of *Birrell*.

74. *Logan*'s wireless power transfer is based on inductive coupling. (*Id.*, Abstract, 2:18-26, 7:21-26.) For example, *Logan* discloses transmitting and receiving wireless power using coil 12 ("first inductor") and coil 16, where an oscillator 10 energizes coil 12 to create an "alternating electromagnetic flux," which in turn induces an electromotive force in coil 16 for powering an LED 20. (*Id.*, Abstract, 3:19-5:4; FIGS. 1-2.) Thus, *Logan* discloses a device including an "inductor" to transmit power from the device wirelessly to another device through, e.g., a partition or an insulator, which is similar to the arrangement described by *Birrell*.



(Ex. 1006, FIG. 2 (annotated to show coils 12 and 16, oscillator 10, and LED 20).)

75. Based on *Birrell* and *Logan*, a person of ordinary skill in the art would have been motivated to modify *Birrell*'s system so as to utilize inductive coupling, similar to as described by *Logan*, to provide wireless power. *Logan* discloses that using inductive coupling to transmit wireless power (*see*, *e.g.*, Ex. 1006, 3:19-23) is particularly beneficial for a lighting system that includes multiple LEDs devices. Specifically, *Logan* explains that given the "concentrated and localised nature" of the inductively generated field, LED lightings "can be densely packed without interference problems." (*Id.*, 6:3-11; *see also id.*, 1:6-17, 1:18-24 (*Logan* "provide[s] a system…which enables large numbers of individual transmitter/receiver pairs to be positioned in relatively close proximity to each other

without mutual interference between adjacent channels.").) Thus, a person of ordinary skill in the art would have been motivated to implement *Logan*'s teachings/suggestions when contemplating *Birrell*, especially when *Birrell* itself discloses closely packing multiple light tiles. (Ex. 1005, 13:37-14:2 (packing four light tiles 50 close to each other as shown in Figure 3), 23:30-24:2 (multiple light tiles connected in a network as shown in Figure 10A).)

76. Furthermore, such a skilled person would have appreciated that using inductive coupling to provide wireless power in *Birrell* would allow for voltage magnitude adjustments by adjusting the windings of the coils. Indeed, a person of ordinary skill in the art would have known that if the transmitting coil has more windings than the receiving coil, the magnitude of the transmitted voltage would be reduced and vice versa, providing flexibility when implementing wirelessly powering devices of different voltage requirements. (Ex. 1013, 161-162; Section V.A (e.g., ¶¶25, 33).) Additionally, *Logan* explains that its inductive coupling-based system "can operate with a wide variety of panel/bulkhead materials," e.g., "aluminium and its alloys, plastics and stainless steel" as well as "[f]errous materials" (Ex. 1006, 4:1-5) and a person of ordinary skill in the art would have known that an inductively-coupled system or apparatus has improved transfer characteristics when properly configured (*see e.g.*, Ex. 1012, 2:12-19, 2:31-43, 4:50-5:48, FIGS. 1, 4-5; *infra* Section IX.I.1(d)). Thus, a person of ordinary skill in the

art would have appreciated that providing similar features in *Birrell*'s apparatus would have improved the flexibility in its design and implementation to accommodate different applications.

77. Additionally, there were only a handful of known techniques for transmitting power wirelessly, including inductive coupling, capacitive coupling, magnetic resonance coupling, microwave, and laser. Thus, a person of ordinary skill in the art would have been motivated to use one of those wireless power transmission techniques, e.g., inductive coupling, similar to as disclosed in *Logan*, with *Birrell* for wireless power transmission.

78. A person of ordinary skill in the art would have had the capability and a reasonable expectation of success in implementing inductive coupling in a system like *Birrell*, given the skills/knowledge of such a person at the time and that both *Logan* and *Birrell* describe features for wirelessly powering LED devices and that inductive coupling was a known technique. (Ex. 1013, 161-162, 165-166, FIG. 5-4(c).) Indeed, a person of ordinary skill in the art would have recognized that implementing the above modification would have involved applying known technologies (e.g., wireless power (like *Logan* and *Birrell*) with inductive coupling (like *Logan*)) according to known methods (e.g., use of inductors to transmit/receive wireless power) to yield the predictable result of providing wireless power to LED

lighting device(s) with reduced interference and with the flexibility to adjust the transmitted voltage for particular applications.

79. For example, in one non-limiting way (others would have been contemplated), the modification would have involved implementations of known configurations, such as an example from a 1998 textbook, (Ex. 1013, FIG. 5-4(c)), where the capacitive coupling features formed by capacitors C_A and C_B as shown in Figure 8 of *Birrell* were modified with inductive coupling features formed by inductors (and related circuitry) similar to Figure 2 of *Logan*. A person of ordinary skill in the art would have further considered necessary design adjustments, e.g., operating voltage, frequency, power,…etc., to the circuitry to ensure the modification properly provided power consistent with *Birrell*'s operations. As such, the modification would have predictably resulted in use of an inductor to wirelessly transmit power (provided by *Birrell*'s AC power supply) to another inductor in lighting tile 50 to eventually power the LEDs 59 (exemplified in general form below).[4]

[4] The exemplary modified arrangement (the demonstratives here and below) is/are a high-level exemplary and non-limiting illustration(s), and does/do not necessarily depict(s) an exact schematic(s) of the details included and the only arrangement(s)

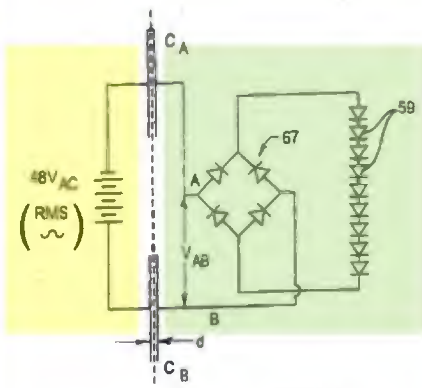


FIG 8

Birrell

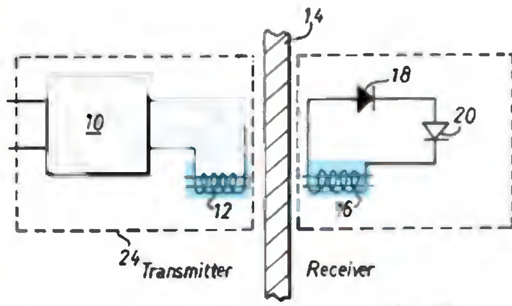
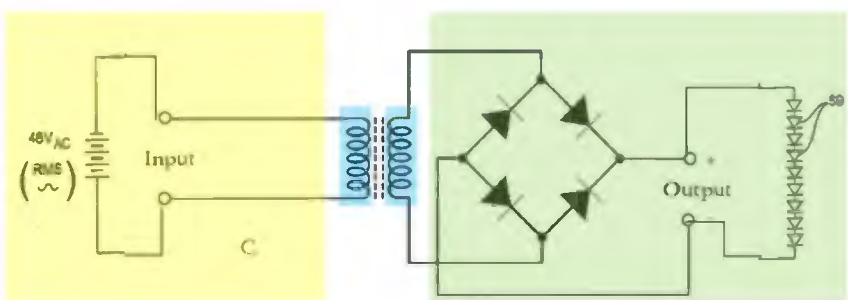


Fig 2

Logan

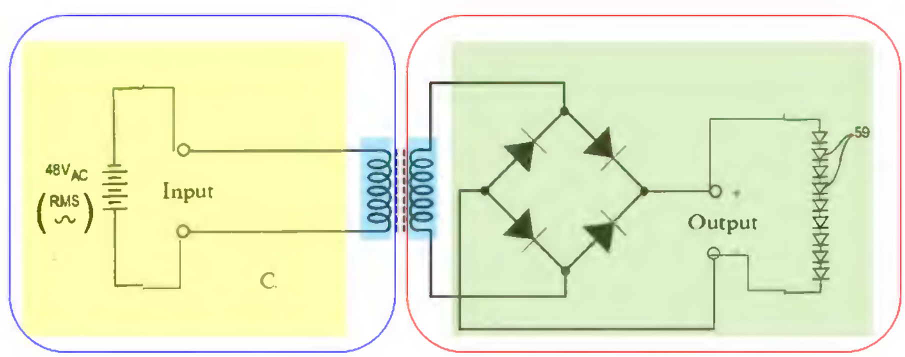


Demonstrative A

resulting from the modification. Other designs/configurations including components and paths not shown may have been contemplated by a person of ordinary skill in the art when designing/implementing such a modified apparatus.

(Ex. 1005, FIG. 8 (top left); Ex. 1006, FIG. 2 (top right); Demonstrative A (bottom) (annotated based on Ex. 1013, FIG. 5-4(c)).)

80. Thus, in my opinion, the *Birrell-Logan* combination discloses the claimed "first device" (e.g., exemplified below in blue box of Demonstrative F, including a "first circuit" comprising the conductor extending from the power supply ("first transmission conductor") and a "first inductor" (transmitting coil) used to transmit power from the "first device" wirelessly to the modified tile 50.



Demonstrative F

(Demonstrative F (annotated based on Ex. 1013, FIG. 5-4(c)).)

c) a second device including

(1) (a) at least one LED,

(2) (b) a second circuit configured to detect contact with a conductive substance via capacitive sensing for controlling the at least one LED, and

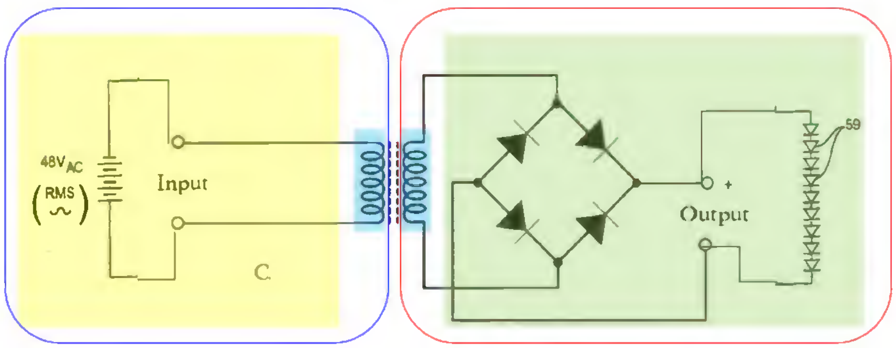
81. The above *Birrell-Logan* combination discloses/suggests the claimed "second device." For example, *Birrell* discloses that lighting tile 50 includes multiple LEDs 59 ("at least one LED"). (Ex. 1005, 14:26-15:33, FIG. 8.) *Birrell*'s lighting tile 50 also includes a "second circuit" configured to detect contact as claimed.

82. In particular, lighting tile 50 includes a capacitive touch sensor ("second circuit configured to detect contact") that detects contact of a human touch. (*Id.*, 16:18-26 (disclosing that the touch sensor "acts as a high impedance capacitive pick up for **human touch sensing**"); *see also id.*, 15:21-33 (disclosing with reference to Figure 1 that "[s]ensors 60 are also disposed on the circuit board 58" of lighting tile 50, where "[t]he sensors may include … touch sensor conditioning electronics").) The disclosed touch sensor necessarily includes a "[second] circuit" as claimed because without circuitry (e.g., including conductive paths and components known to part of such known touch sensor component(s)), the touch sensor would not operate as described in *Birrell* (e.g., the touch sensor "enable[s] the lighting tile 50 to be controlled"). (*Id.*, 16:18-26.) Indeed, a person of ordinary

skill in the art would have understood that the touch sensor, like other components of lighting tile 50, requires power for functioning, and power requires current flowing in a circuit. (Section V.A.)

83. Furthermore, such a skilled person would have understood that a person is a "conductive substance." (Ex. 1001, 20:30-36 ("a conductive substance such as a person, including the touch of a person (human touch), or metallic material …").) Thus, *Birrell* discloses "a second circuit configured to detect contact with a conductive substance via capacitive sensing." *Birrell*'s touch sensor also includes a metallised polymer film 64 that "enable[s] the lighting tile 50 to be controlled," which a person of ordinary skill in the art would have understood included the LEDs. (Ex. 1005, 16:18-26.) A person of ordinary skill in the art would have understood that in referencing control of the lighting tile 50, *Birrell* was referring to control of the LEDs within lighting tile 50. *Birrell* discloses that the lighting tile "includes integrally embedded electronic manual controls such as **touch switches or light level controls**." (*Id.*, 8:4-7.) Thus, *Birrell* discloses the claimed "second device" including "a second circuit" for controlling the at least one LED in tile 50. Such circuit is configured to detect contact with a human (which is a "conductive substance") or detect contact using a conductive substance because the capacitive touch sensor includes a "metallised polymer film 64" (also a "conductive substance" and "enable[s] the lighting tile 50 to be controlled." (*Id.*, 16:18-26.)

84. In light of such disclosures, and for the reasons I discussed above for limitation 1(b), the *Birrell-Logan* modified lighting tile 50 discloses/suggests a "second device" (exemplified below in red box of Demonstrative F), which includes LED(s) and a "second circuit" as claimed.



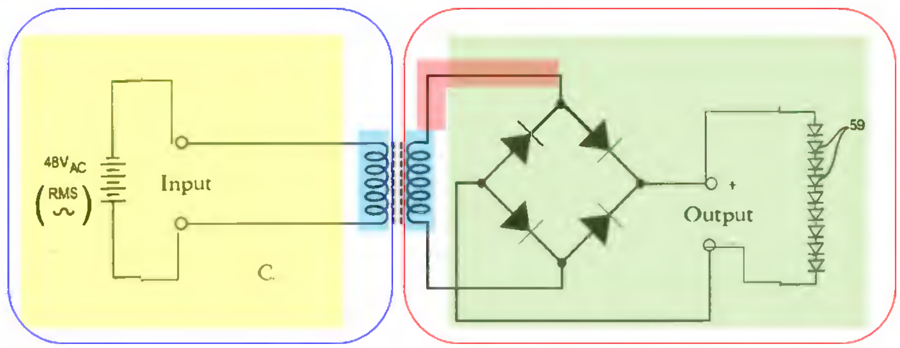
Demonstrative F

(Demonstrative F (annotated based on Ex. 1013, FIG. 5-4(c)).)

(3) (c) a third circuit having a second transmission conductor and a second inductor, wherein said second device is configured to use at least the second inductor to receive power wirelessly from said first device for powering the apparatus.

85. The *Birrell-Logan* combination discussed above discloses and/or suggests this limitation. (*See* above at Sections IX.A.1(b), IX.A.1.(c)(2).) As I explained, the modified lighting tile 50 ("second device") of the *Birrell-Logan* combination would have been inductively coupled to the "first device" via a receiving coil ("second inductor") to wirelessly receive power from the "first

device." (*See* claim limitation 1(b); Section IX.A.1(b).) Thus, for similar reasons, the modification would have resulted in modified lighting tile 50 including a "third circuit," which includes a conductor ("second transmission conductor") extending from the receiving coil ("second inductor") that receives power wirelessly from the "first device" that is used for powering the LEDs 59. (Ex. 1005, 20:26-31 ("LEDs [are] … coupled to an AC power supply" and that the power supply "illuminate[s] the LEDs"); *id.*, 8:31-9:10 (system is "able to provide both data and power through the electrical coupling"), 22:29-30 ("a 48 Volt AC power supply of 80kHz will satisfactorily illuminate the LED's of Figure 8.").) As such, and exemplified below in Demonstrative B, in the *Birrell-Logan* combination, the transmitting coil ("first inductor" (blue coil on left)) in the "first device" (blue box) would wirelessly transmit power to the receiving coil ("second inductor" (blue coil on right) of the modified tile 50 ("second device" (red box)) for powering LEDs 59 via an electrical connection ("second transmission conductor" (e.g., red path, which may also extend to LEDs 59)). (Section IX.A.1(b); Ex. 1005, FIG. 8.)



Demonstrative B

(Demonstrative B (annotated based on Ex. 1013, FIG. 5-4(c)).)

2. Claim 3

a) The apparatus of claim 1, wherein said second device is adapted to receive power from a power supply connected to an AC mains.

86. The *Birrell-Logan* combination discloses and/or suggests this feature. As I discussed above, *Birrell* discloses a "second device" (modified tile 50) that wirelessly receives power from a 48V AC power supply. (Ex. 1005, 20:26-31 ("LEDs [are] … capacitively coupled to an AC power supply" and that the power supply "illuminate the LEDs."); *id.*, 8:31-9:10, 22:29-30 ("a 48 Volt AC power supply … will satisfactorily illuminate the LED …."); Section IX.A.1(b).) While *Birrell* does not expressly disclose that the 48V AC power supply is "connected to an AC mains," a person of ordinary skill in the art would have been motivated to implement such features in the *Birrell-Logan* modified apparatus.

87. A person of ordinary skill in the art would have understood that 110/120V AC power from the electrical grid is a commonly used and convenient way of providing power to lighting fixtures and other electronics. (Ex. 1013, 157 (120V AC used to power lighting fixtures); Ex. 1024, 1:9-28 ("standard line voltage available from wall outlets is AC"), 1:35-48, FIG. 1; Ex. 1025, 1:10-25, FIG. 1 (AC-DC converter).) Such a skilled person would have also understood that such AC voltage can be adjusted by using a transformer to a voltage suitable for the electronic device to be powered. (Ex. 1013, 161-162, 165-166.) Accordingly, a person of

ordinary skill in the art contemplating the above modified *Birrell-Logan* apparatus would have been motivated to, e.g., connect an AC mains to the 48V AC source and provide power via the "first device" to supply a constant source of power, which would have been adjusted to an appropriate voltage for the apparatus (e.g., 120 V to 48 V) using known components, such as transformer or the like. A person of ordinary skill in the art would have found such a configuration beneficial because it would provide a known predictable source of power typically used in the types of applications contemplated by *Birrell* and *Logan*. (Ex. 1005, 4:24-38; Ex. 1006, 1:3-5, 2:1-6, 4:1-22.) Moreover, a person of ordinary skill in the art would have had a reasonable expectation of success implementing this feature given that use of 120V AC from the electrical grid and use of a transformer to convert the AC power to a different or appropriate voltage were well known. (Ex. 1013, 161-162, 165-166; Section V.C (e.g., ¶¶47-48).) Indeed, such a skilled person would have found the above modification to have been a mere combination of known components and technologies, according to known methods, to produce predictable results of providing power to the modified light system of *Birrell*. (Ex. 1022, FIG. 2.1, ¶¶[0082]-[0084].) Thus, the above-modified *Birrell-Logan* combination would have predictably resulted in the second device adapted to receive power from a power supply connected to an AC mains because the modified lighting tile 50 receives

power from the 48V AC power supply that is connected to the AC mains as modified above.

3. Claim 4

a) The apparatus of claim 1, wherein said first device is configured to transmit power and data.

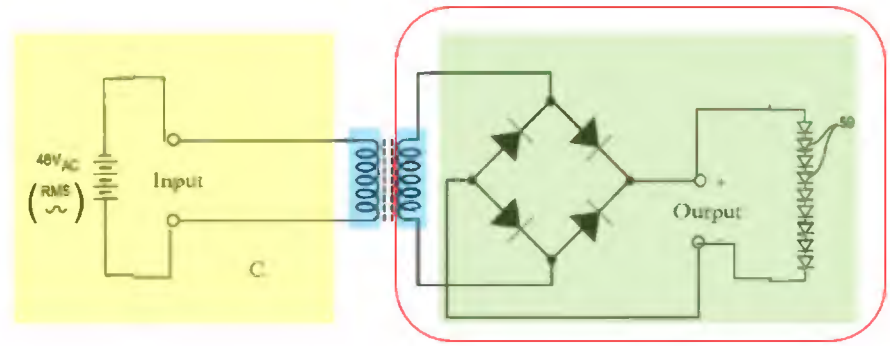
88. The *Birrell-Logan* combination discloses and/or suggests this feature. The "first device" in the modified *Birrell-Logan* apparatus discussed for claim 1 (*see* Section IX.A.1(b)) transmits both data and power wirelessly because *Birrell* explains that its arrangement is "able to **provide both data and power through the electrical coupling** …." (Ex. 1005, 8:31-9:10; *see also id.*, 9:11-29, 13:15-23 ("lighting elements may be controlled by data transmitted with the power supply"), 23:15-21 ("**all data is transferred by the same electrical path that is used for the electrical power transfer**," where "**data is superpositioned on the primary power**.").) *Logan* also discloses transmitting both power and data wirelessly through its inductive coupling. (Ex. 1006, 3:24-28, 5:18-6:2 (disclosing that "**data can be superimposed on a carrier and transmitted through a panel**," where "[c]arrier can then be demodulated to **power and control a receiver unit**" and that "[t]wo-way transmission is possible with such a system").) Thus, a person of ordinary skill in the art would have been motivated to configure the *Birrell-Logan* combined apparatus such that the device providing **power** ("first device") to the

modified tile 50 ("second device") is also configured to transmit **data** consistent with the functionalities contemplated by *Birrell*. Such a skilled person would have had the same knowledge, skills, and expectation of success to implement the modification as I explained above for claim 1. (Sections IX.A.1(b)-(c).)

4. Claim 10

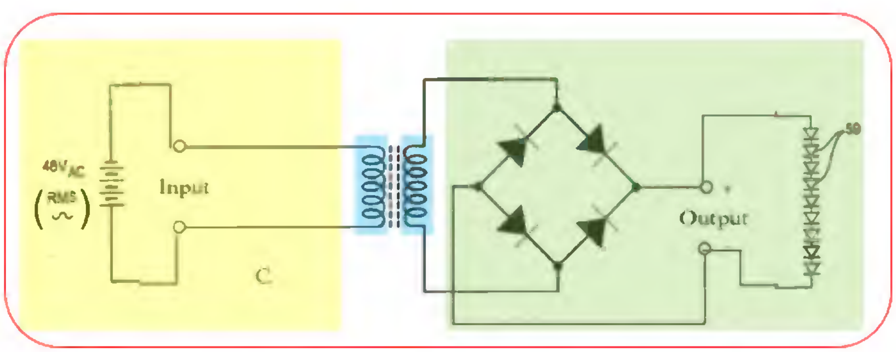
a) An apparatus comprising:

89. I understand that this phrase is the preamble of claim 10, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell*'s lighting tile 50 is an "apparatus." (Ex. 1005, 14:26-15:33; *see* above at Section IX.A.1(a); *see* below at Sections IX.A.4(b)-(e).) Further, the *Birrell-Logan* combination (discussed below for limitation 10(e)) discloses the claimed apparatus in ***two ways***. (*See* below at Section IX.A.4(e) and above at Section IX.A.1(b)) (explaining how and why a person of ordinary skill in the art would have been motivated to modify *Birrell* in view of *Logan* to provide an apparatus that includes inductive coupling features).) ***First***, as exemplified by the red box below, the modified lighting tile 50 in the discussed *Birrell-Logan* combination is an "apparatus" as claimed because it includes the features recited in limitations 10(b)-(e). (*See* below for Sections IX.A.4(b)-(e).)



Demonstrative A (annotated)

Second, as further exemplified in the red box below, the modified tile 50 with coils and the power supply device providing power (and interconnected circuitry and components) in the *Birrell-Logan* combination is an "apparatus."



Demonstrative A (annotated)

b) an LED circuit comprising at least one LED;

90. *Birrell* discloses that lighting tile 50 includes multiple LEDs 59 having at least one LED. (Ex. 1005, 14:26-15:33.) A person of ordinary skill in the art would have understood that LEDs 59 in combination with other circuit components, e.g., the conductive wires connecting the LEDs and wires connecting the LEDs to receiver power and thus current, is an "LED circuit" like that claimed. (Section V.A.)

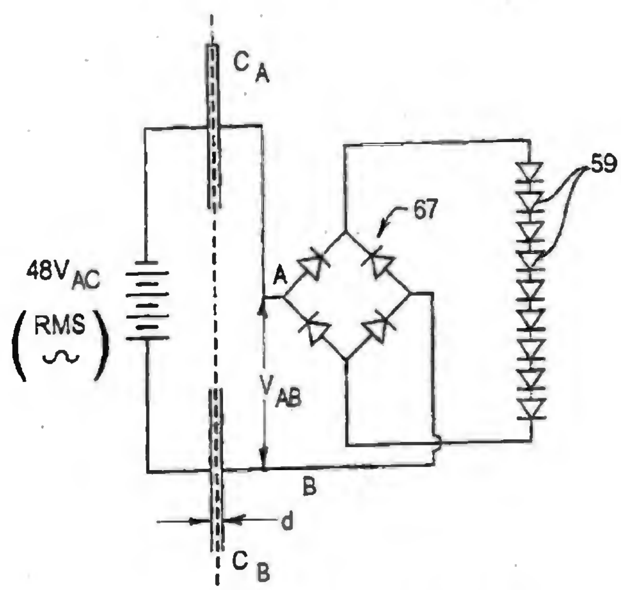


FIG 8

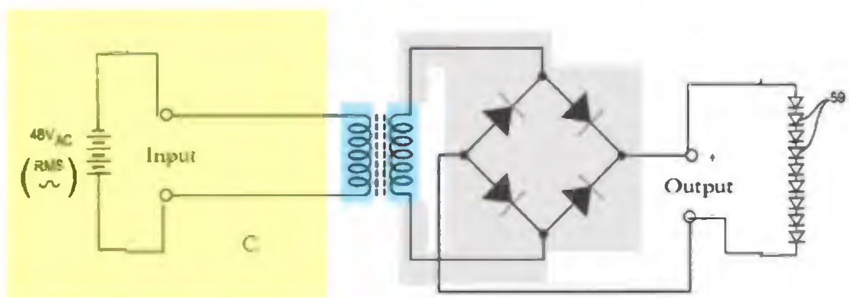
(Ex. 1005, FIG. 8 (showing LEDs 59.) Thus, any of the above identified "apparatus[es]" in the *Birrell-Logan* combination discussed for limitation 10(a) includes such an "LED circuit" because they include LEDs 59. (*See* above at Section IX.A.4(a).)

c) a power supply, wherein said power supply is configured to provide power to the apparatus and is configured to receive power wirelessly from a power source;

91. The *Birrell-Logan* combination discloses and/or suggests this limitation in two ways.

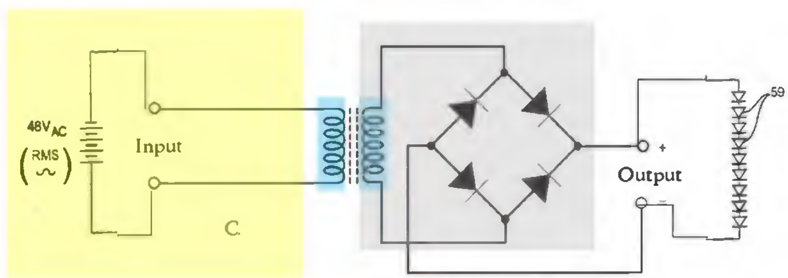
92. ***First***, a person of ordinary skill in the art would have been motivated to modify *Birrell* in view of *Logan* to provide inductive coupling for the reasons I explained for claim limitations 1(b)-1(c) and below for claim limitation 10(e) (*See* above at Sections IX.A.1(b)-(c); *see* below at Section IX.A.4(e).) In such a *Birrell-Logan* combination, the rectifier (formed by diodes 67) and conductors connecting the receiving coil in the *Birrell-Logan* combination (exemplified in grey below (Demonstrative D)) discloses the claim 10's "power supply" because it provides power to power LEDs 59 in the "apparatus." (Section IX.A.1(b); Ex. 1005, FIG. 8, 19:1-7 (diodes 67 form a bridge rectifier "ensur[ing] that light is emitted from the LEDs during both the positive and negative cycles of the AC power supply coupled via capacitors connections 66"); Ex. 1013, 163 (state of art knowledge that "[r]ectification is a process in which AC is converted to DC"), 164-167 (bridge rectifier known to include a capacitor, for example, to filter the DC power); Ex. 1001, 4:23, 9:57-65; Section V.B (e.g., ¶¶40-41).) In this way, each identified *Birrell-Logan* apparatus (*see* limitation 10(a)) includes a "power supply" as claimed

(e.g., including the rectifier formed by diodes 67 and conductors connecting the receiving coil, which provides power to LEDs)) as it is configured to wirelessly receive power from a power source via its connection to the receiving coil in modified tile 50 that wirelessly receives power from the transmitting coil in the *Birrell-Logan* combination (*see e.g.,* Ex. 1005, FIG. 8, FIG. 10 (power supply 11)).



Demonstrative D

93. ***Second***, the rectifier (formed by diodes 67), the receiving coil, and the conductors connecting the receiving coil in the modified tile 50 of the *Birrell-Logan* combination disclose the claimed "power supply" (exemplified in grey below in a non-limiting manner (Demonstrative E)) because it provides power to LEDs 59 in the identified "apparatus" (limitation 10(a)) and is configured to receive power wirelessly (via receiving coil and conductors in the modified tile 50) from a power source (e.g., FIG. 8 (48V AC power source)) via the transmitting coil.



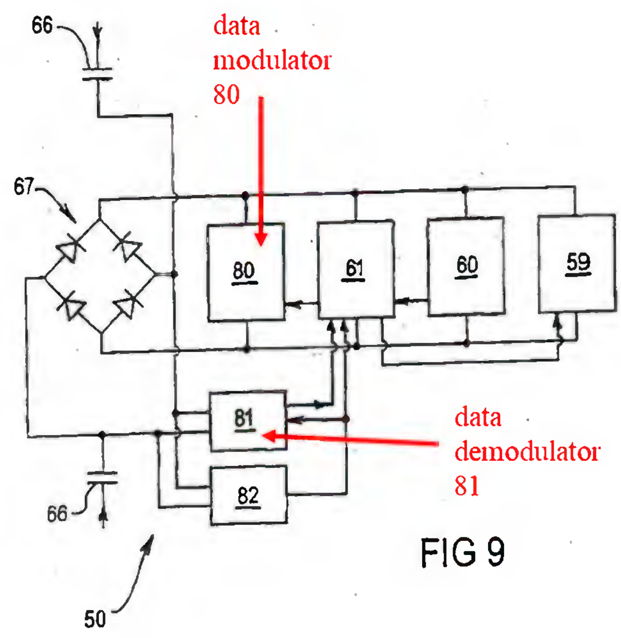
Demonstrative E

d) a circuit configured to detect contact with a conductive substance for controlling at least the LED circuit; and

94. *Birrell* discloses this limitation for the same reasons discussed above for claim limitations 1(c)(2) and 10(b) (describing that LEDs 59 in combination with other circuit components is a "LED circuit"). (*See* above at Sections IX.A.1(c)(2) and IX.A.4(b).)

e) a data receiver, wherein said data receiver is configured to receive data from an antenna.

95. The *Birrell-Logan* combination discloses and/or suggests this feature. For example, *Birrell* discloses tile 50's circuitry is "structured so that all data is transferred by the same electrical path that is used for the electrical power transfer" (Ex. 1005, 23:15-21), where data are transmitted using a data modulator 80 and **received using a data demodulator 81** ("data receiver") (*id.*, 16:4-8, 23:22-29; FIG. 9).



(Ex. 1005, FIG. 9 (annotated to show data modulator 80 and data demodulator 81).)

96. Additionally, in the *Birrell-Logan* combination discussed above, power and data are received using an inductive coil at the modified lighting tile 50 in the form of an alternating electromagnetic field and the coil converts the alternating electromagnetic field into an alternating current. (Ex. 1006, Abstract, 3:19-5:4; FIGS. 1-2; Ex. 1013, 161-166 (describing that an alternating current is generated through inductive coupling); *see above* at Sections IX.A.1.(b)-(c), IX.A.3, IX.A.4(a), IX.A.4(c).)) Therefore, a person of ordinary skill in the art would have understood that the receiving coil is an "antenna." (Ex. 1013, 110 (disclosing that "[a] receiving antenna converts an electromagnetic (EM) field to an alternating current (AC)").) Given that data (and power) are received using the receiving coil

("antenna") in the modified lighting tile 50, and the received data are demodulated using data demodulator 81 ("data receiver"), the *Birrell-Logan* combination discloses "a data receiver, wherein said data receiver is configured to receive data from an antenna."

5. Claim 11

a) The apparatus of claim 10, wherein said circuit is configured to detect contact with the conductive substance via capacitive sensing.

97. The *Birrell-Logan* combination discloses and/or suggests this limitation for the same reasons discussed above for claim limitation 1(c)(2). (*See* above at Section IX.A.1(c)(2).)

6. Claim 12

a) The apparatus of claim 10, wherein said apparatus is configured to receive power from an AC mains power supply.

98. The *Birrell-Logan* combination discloses and/or suggests this limitation for the same reasons discussed above for claim 3. (*See* above at Section IX.A.2.)

7. Claim 13

a) An apparatus comprising:

99. I understand that this phrase is the preamble of claim 13, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* alone or in combination with *Logan* discloses the

limitations in the preamble. *Birrell* discloses this preamble for the same reasons discussed above for limitation 10(a) above and limitations 13(b)-(d) below. (*See* above at Section IX.A.4 ; *see* below at Sections IX.A.7(b)-(d).)

b) a flat planar substrate upon which is mounted a plurality of LEDs;

100. *Birrell* discloses this limitation. For example, *Birrell* discloses with reference to Figure 1 that "mounted on the circuit board 58 includes nine LEDs 59." (Ex. 1005, 15:18-21, FIG. 1.) Given that *Birrell* discloses that the "preferred form of the present invention" is "a thin and generally **planar** lighting element" (*id.*, 13:15-17) and that *Birrell* describes that the lighting device is a "tile" (*see*, *e.g.*, *id.*, Abstract), a person of ordinary skill in the art would have understood that *Birrell* discloses "a flat planar substrate upon which is mounted a plurality of LEDs," consistent with that shown in Figure 1, where circuit board 58 is a planar substrate upon which is mounted a plurality of LEDs 59. (*Id.*, FIG. 1.) In context of the *Birrell-Logan* combination, such features would have been included in the modified tile 50 (*see* Section IX.A.7(a).)

c) a data receiver, wherein the data receiver is configured to receive data from an antenna; and

101. The *Birrell-Logan* combination discloses and/or suggests this limitation for the same reasons discussed for claim limitations 10(a), 10(c), and 10(e). (*See* above at Sections IX.A.4(a), IX.A.4(c), and IX.A.4(e).)

d) a circuit configured to detect contact with a conductive substance for controlling the plurality of LEDs.

102. The analysis for limitation 1(c)(2) explains how *Birrell* discloses the claimed "circuit", which would have been incorporated in the *Birrell-Logan* combination discussed above. (*See* above at Sections IX.A.1(c)(2), IX.A.7(a)-(c); Ex. 1005, FIG. 1, 15:18-21 (lighting tile 50 including "nine LEDs 59").) For those reasons, the *Birrell-Logan* combination discloses claim limitation 13(d).

8. Claim 14

a) The apparatus of claim 13, wherein power is provided to said plurality of LEDs after said circuit detects the contact with the conductive substance.

103. *Birrell* alone or in combination with *Logan* discloses this limitation for the same reasons discussed above for claim limitation 1(c)(2) and those discussed below. (*See* above at Section IX.A.1(c)(2).) For example, *Birrell* discloses that a touch sensor "enable[s] the lighting tile 50 to be controlled" (Ex. 1005, 16:18-26) and that the lighting tile "includes integrally embedded electronic manual controls such as **touch switches or light level controls**" (*id.*, 8:4-7). A person of ordinary skill in the art would have understood that switching an LED on or changing the light level of an LED involves providing power to the LED. *Birrell* discloses that "LEDs [are] … coupled to an AC power supply" and that the power supply "illuminate[s] the LEDs." (*Id.*, 20:26-31; *see also id.*, 8:31-9:10 (the system is "able to provide both data and power through the electrical coupling"), 22:29-30 ("a 48

Volt AC power supply … will satisfactorily illuminate the LED's ….").) As such, a person of ordinary skill in the art would have understood that by enabling LEDs to be switched on, or have their light level controlled, upon detecting contact with a conductive substance (*see* above at Section IX.A.1(c)(2)), *Birrell* discloses that "power is provided to said plurality of LEDs after said circuit detects the contact with the conductive substance." (Ex. 1005, 16:18-26 (disclosing that the capacitive touch sensor "enable[s] the lighting tile 50 to be controlled."); *see also id.*, 15:21-33 (disclosing with reference to Figure 1 that "[s]ensors 60 are also disposed on the circuit board 58" of lighting tile 50, where "[t]he sensors may include … touch sensor conditioning electronics").) A person of ordinary skill in the art would have been motivated to implement such features in the *Birrell-Logan* combined apparatus because it would have maintained the functionalities disclosed by *Birrell* as discussed above.

9. Claim 15

a) The apparatus of claim 13, wherein said LEDs are organic LEDs.

104. *Birrell* discloses this limitation as it discloses using "organic polymer LED materials" as light sources, which would have been implemented in the *Birrell-Logan* combination discussed above in claim 13 for the same reasons. (Ex. 1005, 11:35-12:3; *see* above at Section IX.A.7.)

10. Claim 17

a) An apparatus comprising:

105. I understand that this phrase is the preamble of claim 17, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitations in the preamble. *Birrell* discloses this preamble for the reasons discussed above for claim limitation 10(a). (*See* above at Section IX.A.4(a); *see* below at Sections IX.A.10(b)-(e).)

b) an LED circuit comprising at least one LED;

106. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 10(b). (*See* above at Section IX.A.4(b).)

c) a circuit configured to detect contact with a conductive substance for at least controlling the LED circuit; and

107. *Birrell* discloses this limitation for the same reasons discussed above for claim limitations 1(c)(2) and 10(d). (*See* above at Sections IX.A.1(c)(2) and IX.A.4(d).)

d) a data receiver, wherein said data receiver is configured to receive data from an antenna,

108. The *Birrell-Logan* combination discloses this limitation for the same reasons discussed above for claim limitations 10(a), 10(c), and 10(e). (*See* above at Sections IX.A.4(a), IX.A.4(c), and IX.A.4(e).)

e) wherein said apparatus is portable.

109. The *Birrell-Logan* combination discloses and/or suggests that the "apparatus" is portable. For example, *Birrell* discloses that lighting tile 50 may be conveniently "removed from a supporting structure." (Ex. 1005, 15:8-14; *see also id.*, 2:14-35 (describing that *Birrell* solves problems associated with lighting devices having fixed locations and wiring by providing a lighting tile that "exhibit[s] enhanced flexibility for installation and control").) Furthermore, *Birrell* discloses that the lighting tile may be implemented on an "advertising display, or a piece of furniture such as a table surface [for reading purposes]." (*Id.*, 4:24-32.) Thus, the combined *Birrell-Logan* apparatus would likewise have been "portable."

11. Claim 18

a) An apparatus comprising:

110. I understand that this phrase is the preamble of claim 18, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitations in the preamble. *Birrell* discloses this preamble for the same reasons discussed above for claim limitation 10(a). (*See* above at Section IX.A.4(a) ; *see* below at Sections IX.A.11(b)-(d).)

b) a flat planar substrate upon which is mounted a plurality of LEDs;

111. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 13(b). (*See* above at Section IX.A.7(b).)

c) a transmission conductor configured to provide data and power to said apparatus; and

112. *Birrell* discloses this limitation. As exemplified below, *Birrell* discloses that its lighting tile 50 includes a "transmission conductor," which receives wireless power from the power supply and provides power to the LEDs. (Section IX.A.1(c)(3); Ex. 1005, FIG. 8 (annotated).)

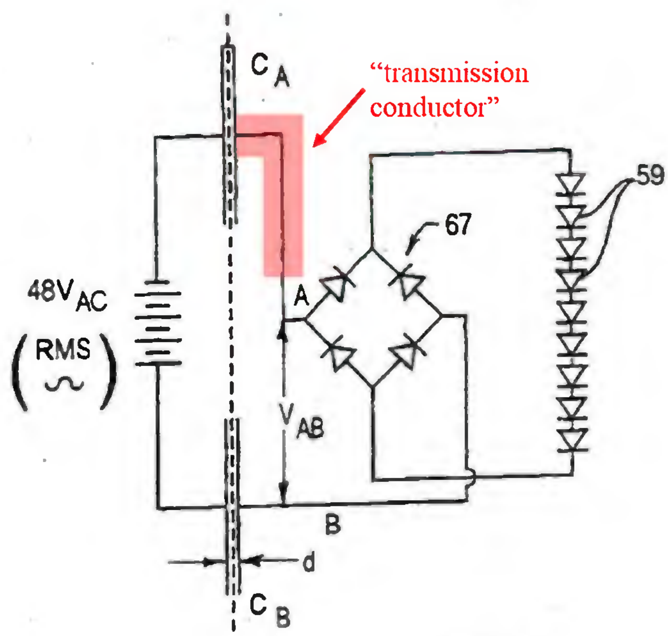


FIG 8

(Ex. 1005, FIG. 8 (annotated to show a "transmission conductor").)

113. Furthermore, as I discussed, *Birrell* discloses that "all data is transferred by the same electrical path that is used for the electrical power transfer" (Ex. 1005, 23:15-21) and that this configuration is "able to provide both data and power through

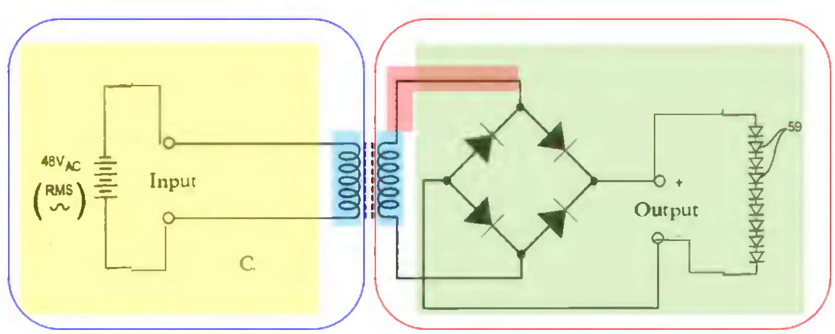
the electrical coupling (*id.*, 8:31-9:10). (*See* above at Section IX.A.3.) Thus, the "transmission conductor" that is connected to the capacitive coupling in lighting tile 50 (*e.g.*, Ex. 1005, FIG. 8) provides power and data to tile 50 ("apparatus").

d) a data receiver, wherein the data receiver is configured to receive the data from the transmission conductor or an antenna and the power from the transmission conductor.

114. The *Birrell-Logan* combination discloses or suggests the data receiver receives the data from an antenna and power from the above "transmission conductor." My analysis for claims 1(b)-1(c) explains how and why a person of ordinary skill in the art would have been motivated in view of *Logan* to configure the *Birrell* system to utilize inductive coupling to transmit power to lighting tile 50 ("apparatus" of claim 18(a)). (Sections IX.A.1(b)-(c).) Furthermore, my analysis for claim 10(e) explains how the modified tile 50 in the *Birrell-Logan* combination includes data demodulator 81 ("data receiver") configured to receive data and power from the receiving coil, which is an "antenna." (Section IX.A.4(e).) Thus, the *Birrell-Logan* combination discloses or suggests limitation 18(d) where the data receiver is configured to receive the data from an "antenna" (receiving coil).

115. Additionally, the "transmission conductor" in *Birrell* (discussed for limitation 18(c)) would likewise provide the power to the above "data receiver" in the *Birrell-Logan* combination for similar reasons. Indeed, as I explained for

limitation 1(c)(3) (Section IX.A.1(c)(3)), the transmission conductor in the modified tile 50 of the *Birrell-Logan* combination would be connected to the receiving coil and thus would receive data and power, which would have been provided to the modified tile 50's components, including demodulator 81 ("data receiver") consistent with *Birrell*'s operations (discussed above), as exemplified below ("apparatus" (red box)). (Section IX.A.11(c); Ex. 1005, 23:15-29 ("the light tile circuitry is structured so that all data is transferred by the same electrical path that is used for the electrical power transfer"), FIG. 9.) Thus, consistent with *Birrell*, the *Birrell-Logan* combination discloses or suggests a data receiver (demodulator 81 (above) included in modified tile 50 ("apparatus," red box below)) configured to receive the data from an antenna (exemplified below in blue (right)) and the power from the transmission conductor (exemplified below in red below).



Demonstrative B

(Section IX.A.1.c(3).)

12. Claim 19

a) The apparatus of claim 18, wherein the LEDs are Organic LEDs.

116. *Birrell* discloses this limitation for the same reasons discussed above for claim 15. (*See* above at Section IX.A.9.)

13. Claim 20

a) The apparatus of claim 18, wherein said apparatus further comprises a MODEM.

117. *Birrell* discloses this limitation. *Birrell* discloses that "the light tile circuitry is structured so that all data is transferred by the same electrical path … used for … power transfer," where data are transmitted using **a data modulator 80** and received using **a data demodulator 81** (collectively the claimed "MODEM") (Ex. 1005, 23:15-29). (Ex. 1017, 2:19 ("**modem** or **mo**dulator-**dem**odulator"); Ex. 1001, 23:53-60 (data signal receiver 2078 can be a modem).)

14. Claim 21

a) A system comprising:

118. I understand that this phrase is the preamble of claim 21, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitations in the preamble. *Birrell* discloses this preamble for the similar reasons discussed above for claim limitation 1(a). (*See* above at Section IX.A.1(a).) For example, *Birrell* disclose a lighting system (claimed "system") that includes lighting tile 50 ("first device" discussed below for

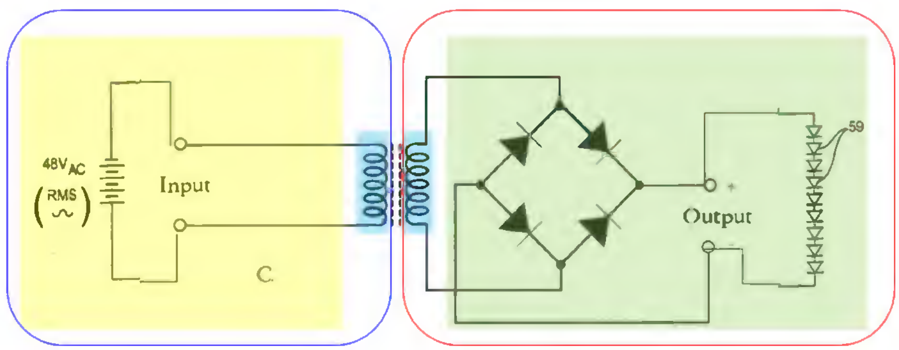
claim limitation 21(b)) and a device ("second device" discussed below for claim limitation 21(c)) having an AC power supply to provide power to tile 50 in context of the combination of *Birrell-Logan*. (*See* below at Sections IX.A.14(b)-(c).)

b) a first device, wherein the first device includes (a) at least one LED, (b) at least one antenna, (c) at least one data communications circuit, and (d) at least one battery, and wherein the first device is configured to detect contact with a conductive substance via capacitive sensing for controlling at least the at least one LED; and

119. *Birrell* in view of *Logan* discloses or suggests this limitation. As I have explained, a person of ordinary skill in the art would have been motivated to configure *Birrell's* lighting system and thus tile 50 to include inductive coupling to wirelessly receive power and data signals in light of *Logan* for reasons discussed for limitations 1(b)-(c) and claims 10, 13, 17-18 (Sections IX.A.1(b), IX.A.1(c), IX.A.4, IX.A.7, IX.A.10-11.) The modified tile 50 ("first device" (exemplified as red box in Demonstrative F below)) in the *Birrell-Logan* combination would have included "at least one antenna" (e.g., receiving coil) and "at least one data communications circuit" (e.g., demodulator 81)[5] as claimed for the same reasons explained for

[5] Additionally, modulator 80 alone or collectively with demodulator 81 is also a "data communication circuit." (Ex. 1005, 16:4-8, 23:22-29; FIG. 9.)

limitations 10(e), 13(c), 17(d), and/or 18(d). (Sections IX.A.4(e), IX.A.7(c), IX.A.10(d), IX.A.11(d).)



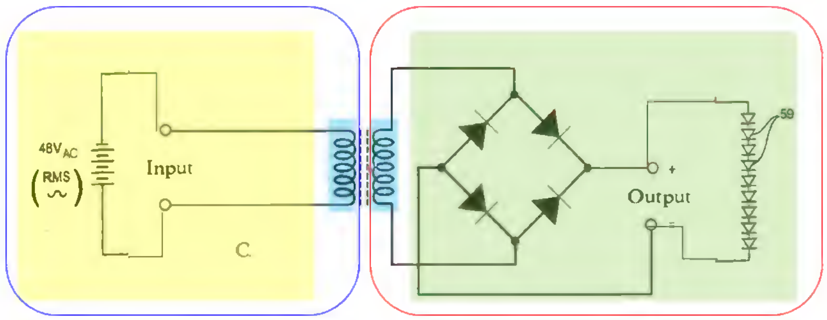
Demonstrative F

120. *Birrell*'s modified lighting tile 50 ("first device") also includes at least one LED (LEDs 59) and is configured to detect contact with a conductive substance via capacitive sensing for controlling at least the at least one LED as claimed for the reasons discussed for claim limitations 1(c)(1)-1(c)(2). (Sections IX.A.1(c)(1)-(2).) Furthermore, the modified "first device" would have also included "at least one battery" given *Birrell* explains that lighting tile 50 includes "energy storage components," which a person of ordinary skill in the art would have understood is a battery and would have been incorporated in the *Birrell-Logan* combination. (Ex. 1005, 15:34-16:10.) And even if such components were not considered a battery, *Birrell*'s disclosures would have motivated a person of ordinary skill in the art to

configure the modified tile 50 to include a battery to achieve the benefit of providing portable power source for the tile. (*See also* below at Section IX.G.1(e) (regarding reasons and motivations to configure the "energy storage components" to be a rechargeable battery to provide power, incorporated and applicable here).) Such a modification would have been within the skills of a person of ordinary skill in the art, who would have recognized the benefits of such a configuration and had a reasonable expectation of success in such an implementation (especially in light of *Birrell*'s "energy storage components" disclosures).

c) a second device, wherein the second device is configured to transmit power and signals wirelessly to the first device.

121. The *Birrell-Logan* combination discloses or suggests this limitation for reasons discussed for claim 4. (*See* above at Section IX.A.3 (where claim 4's mapped "first device" is the same as claim 21(c)'s "second device" in the *Birrell-Logan* combination).) For example, the device in the *Birrell-Logan* combination (exemplified as blue box in Demonstrative F below) is a "second device" that would have been configured to transmit power and data through inductive coupling ("transmit power and signals wirelessly") to the modified lighting tile 50 ("first device") in the combination. (Section IX.A.3; *see also* Section IX.A.1.)



Demonstrative F

15. Claim 23

a) The apparatus of claim 1, wherein the conductive substance includes a metallic material.

122. *Birrell* discloses this limitation in two ways. **First**, as I discussed above for claim limitation 1(c)(2), *Birrell* discloses that lighting tile 50 includes a "**metallised polymer film 64**" ("conductive substance") which "acts as a touch sensor." (Ex. 1005, 16:18-26; Section IX.A.1(c)(2).) A person of ordinary skill in the art would have understood that the "metallised" film includes "a metallic material," and therefore the touch sensor circuit in *Birrell* detects contact with a conductive metallic material substance. Such features would have been implemented in the *Birrell-Logan* combination for the same reasons explained for claim 1. (Section IX.A.1.)

123. **Second,** I have been asked to consider a scenario in which the claim refers to the detection of a conductive substance making contact, where the

conductive substance includes a "metallic material." Under that scenario, a person of ordinary skill in the art would have been motivated to configure the *Birrell-Logan* "apparatus" (claim 1) to allow the touch sensor components of *Birrell* to detect contact from a stylus or similar device having metallic material. A person of ordinary skill in the art would have been motivated to make such a modification given that *Birrell* discloses that its capacitive touch sensor is capable of detecting touch. (Ex. 1005, 16:18-26 (touch sensor "acts as a high impedance capacitive pick up for human touch sensing."); *see also* Ex. 1001, 20:30-36 ("a conductive substance such as a person…").) A person of ordinary skill in the art would have appreciated the many ways capacitive touch sensing can be facilitated (e.g., other types of conductive substances for making contact with a sensor) and that *Birrell*'s sensor was likewise capable of detecting contacts with other conductive substance(s), such as metal-containing input devices. In fact, *Birrell* recognizes that metal wires or the like were a common conductive material(s), which may form elements of capacitive coupling. (Ex. 1005, 14:33-37.) It was also known in the state of art that metal-containing styluses/pointing devices were used in capacitive contact sensing applications. (Ex. 1014, FIGS. 1, 4-6, 8:18-19 (tip 62 of stylus 30 is made of a metal), 7:66-8:11, Ex. 1020, ¶[0018] ("conductive stylus"), [0006], [0038], [0046], [0065]; Ex. 1021, 4:65-5:6 (disclosing that a stylus, e.g., an input pen includes a "conductive pen tip" and "[a] metallic shield member").) Accordingly, a person of

ordinary skill in the art would have been aware of such known features and thus been motivated, with a reasonable expectation of success, to configure the *Birrell-Logan* "apparatus" such that the "second circuit" was configured to also detect contact (for controlling the LED(s)) with a metallic material containing stylus or similar device, to expand the versatility of the modified system. (*See* above Section IX.A.1(c)(2).)

124. The modification would have been a predictable implementation of known technologies and techniques (capacitive touch sensor technologies) that would have resulted in a foreseeable circuit that allowed the touch circuit to accommodate different applications and uses by users of the lighting device. For example, a person of ordinary skill in the art would have appreciate the benefits in expanding the functionality of the *Birrell-Logan* device to accommodate applications where a user may need and/or desire to use an extension, a pointer or a similar device to make contact with tile 50 for controlling the LEDs, which may be helpful where tile 50 is positioned in locations difficult for a user to reach with their outreached hands, and/or where a user wishes to avoid making personal contact with tile 50 (e.g., that is also operated by others) for personal hygiene reasons. Configuring the touch circuitry in the combined apparatus to detect contact from a stylus/pointer that contains a metallic material (e.g., at the tip, etc.) would have been a predictable design configuration from which a person of ordinary skill in the art

would have been able to select from given the known ways to implement capacitive touch sensing systems/devices/components.

B. *Birrell* in view of *Logan* and *Johnson* Discloses and/or Suggests the Features of Claim 2

125. In my opinion, *Birrell* in view of *Logan*, and *Johnson* discloses and/or suggests all of the features of claim 2 of the '298 patent.

1. Claim 2

a) The apparatus of claim 1, wherein said first device comprises at least one colored LED.

126. *Birrell* in view of *Logan* and *Johnson* discloses and/or suggests this limitation. While *Birrell* (as modified) does not expressly disclose that the "**first device** comprises at least one colored LED," a person of ordinary skill in the art would have nonetheless been motivated to implement such features in view of *Johnson*.

127. Like *Birrell*, *Johnson* discloses a power delivery device, i.e., a battery charger. (Ex. 1007, 1:58-2:2.) As such, a person of ordinary skill in the art implementing the system of *Birrell* would have had reason to consider the teachings of *Johnson*. *Johnson* discloses that the power delivery device includes "[t]wo bicolor light emitting diodes (LEDs) 109 and 111" as indicators for signifying status and/or rate of power delivery, i.e., battery charging status and charging rate (*id.*, 2:11-22) as well as whether the power delivery device is connected to a battery for charging (*id.*, 6:55-60).

128. A person of ordinary skill in the art would have been motivated to implement at least one colored LED, similar to as disclosed in *Johnson*, on the AC power supply in the "first device" in the *Birrell-Logan* combination to provide status indications of operation that is associated with the AC power supply. A person of ordinary skill in the art would have appreciated that a colored LED indicator would have allowed a user of the AC power supply (and "first device") to quickly and efficiently determine the status of the power being delivered to the lighting tile 50 and/or determine whether the AC power supply is properly connected to the lighting tile 50. Such a skilled person would have recognized that the colored LED indicator may be used to indicate whether the AC power supply is operational or properly receiving/providing power. The implementation would have been beneficial as *Birrell* discloses that the lighting system is not limited to those mounted on the wall or ceilings, but may also be used in other settings where a user would have access to the AC power supply and first device to determine such status. (Ex. 1005, 4:20-32; *see also id.*, 2:8-13.)

129. A person of ordinary skill in the art would have had the capability, and a reasonable expectation of success in implementing, *Johnson*'s teachings and/or suggestions in a system like the *Birrell-Logan* combination because, e.g., colored LEDs were commercially available and the circuitry to implement such LEDs were well-known. (Ex. 1007, 6:51-60 ("Bicolor LED 109 is a 3 leaded part, such as a LD

1007 available from Siemens, Inc. …"); Ex. 1013, 165-166 (disclosing a well-known rectifier circuit that may be used for powering LEDs); Ex. 1005, FIG. 8 (disclosing a rectifier circuit for powering LEDs); Ex. 1006, FIG. 2 (disclosing a circuit for powering an LED).) Furthermore, the use of LEDs as indicators for a power delivery device was also well-known. (Ex. 1018, 3:41-51 ("the error indicator [of a battery charger] could be an LED"); Ex. 1022, ¶[0087] ("When the line power is interrupted … indicating LED 61 … will not be lighted" and "[a]t this time, the indicating LED 65 will be lighted …."").) The above-described implementation would have involved applying known technologies (e.g., known AC power supply (like *Birrell*) and known colored LED(s) (like *Johnson* and state of the art)) according to known methods (e.g., use of colored LEDs as indicators) to yield the predictable result of using colored LEDs to indicate, e.g., operational and/or power delivery status, providing operational and/or power delivery status indications for ease of use.

C. *Birrell* in view of *Logan* and *Zhang* Discloses and/or Suggests the Features of Claims 3, 10-12, and 21

130. In my opinion, *Birrell* in view of *Logan*, and *Zhang* discloses and/or suggests all of the features of claims 3, 10-12, and 21 of the '298 patent.

1. Claim 3

a) The apparatus of claim 1, wherein said second device is adapted to receive power from a power supply connected to an AC mains.

131. As I discussed above, the combination of *Birrell* and *Logan* discloses/suggests the features of claim 3. (*See* above at Section IX.A.2.) I have been asked to consider a scenario in which the *Birrell-Logan* combination does not itself support such a modification. Under that scenario, in my opinion, *Zhang* further supports that a person of ordinary skill in the art would have been motivated to configure the *Birrell-Logan* combined apparatus to couple an AC mains to a power supply that provides power received by the modified tile 50 ("second device").

132. Like *Birrell*, *Zhang* discloses a power supply providing power to LEDs. (Ex. 1022, ¶¶[0082]-[0084] (disclosing with reference to Figure 2.1 that a 9V AC power supply, through a rectifier 35, is used to power an array of LEDs 19), FIG. 2.1.)

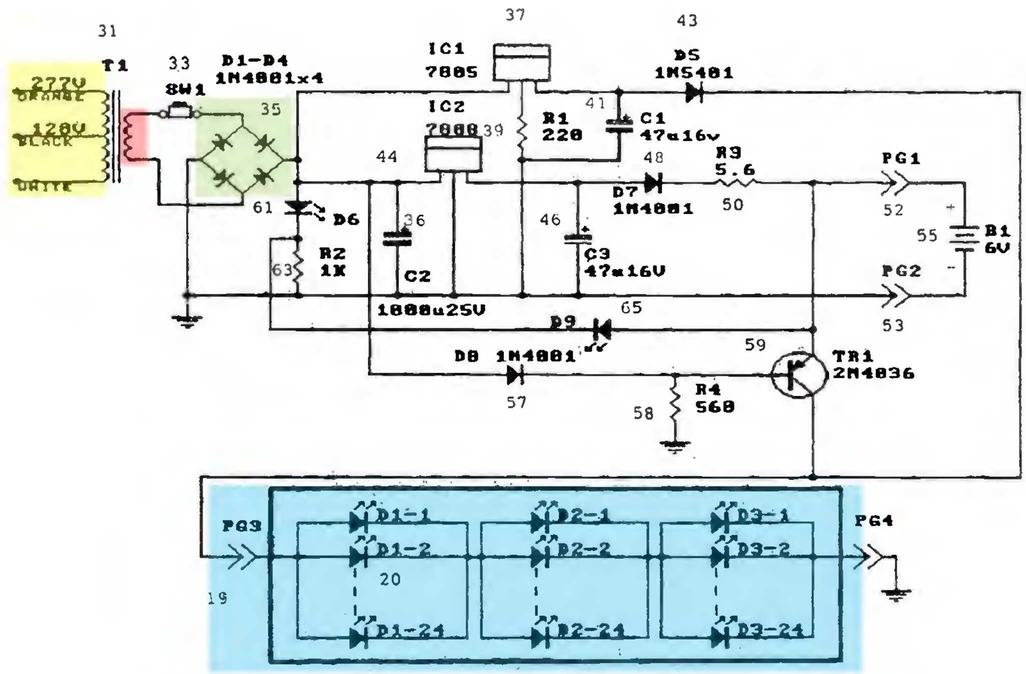


FIG. 4 <EXIT> SIGN
CIRCUIT DIAGRAM

Fig. 2.1, Electronic Circuit Board for LED Exit Sign

(Ex. 1022, FIG. 2.1 (annotated to show 120V AC in yellow, 9V AC in red, rectifier 35 in green, and LEDs 19 in blue).) As such, a person of ordinary skill in the art would have had reason to consider the teachings of *Zhang* when implementing the system of *Birrell*.

133. *Zhang* discloses that the 9V AC is derived from the 120V AC, which is from the commercial line or electrical grid ("AC mains") by using a transformer 31. (Ex. 1022, ¶[0083] ("The 120 VAC or 220 VAC power from the commercial line is reduced to 9 VAC by the transformer 31").) Based on *Birrell* and *Zhang*'s teachings as well as the knowledge of a person of ordinary skill in the art, when implementing

the *Birrell-Logan* combination, such a skilled person would have been motivated to connect the 48V AC power supply (similar to as described in *Birrell*) to a 120V AC commercial line such that it draws power from the electrical grid, similar to as disclosed in *Zhang*. A person of ordinary skill in the art would have understood that 120V AC power from the electrical grid is commonly used, conveniently providing power to lighting fixtures and other electronics. (Ex. 1013, 157 (disclosing that 120V AC may be used to power lighting fixtures); Ex. 1024, 1:9-28 ("Many different electronic devices are powered by direct-current (DC) voltage, as well as alternating-current (AC) voltage. However, standard line voltage available from wall outlets is AC. Therefore, the AC voltage must be conve[rt]ed to a DC voltage by an AC adapter to be used in these electronic devices. AC adapters convert AC voltage (for example, 110 volts at 60 Hertz) from a standard wall outlet to a DC voltage (for example, 12 volts) which is useable by an electronic device such as a calculator, portable stereo, video game, and so on. AC adapters generally include a plug which plugs into a wall outlet, a transformer which steps the line voltage down, a rectifier circuit which rectifies the stepped-down AC voltage to a DC voltage, and a plug which plugs into an electronic device. Numerous types of adapters have been developed …."), 1:35-48 (describing known AC adapter of Figure 1), FIG. 1 (showing known AC adapter); Ex. 1025, 1:10-25 ("Many consumer and commercial devices require direct current (DC) power. Since alternating current (AC) power is

readily available, power supply circuits which convert AC power to DC power are desirable. A block diagram of a conventional power supply circuit 10 is depicted in FIG. 1. The power supply circuit consists of a voltage reducing device 11, rectifier 12, filter 13, and regulator 14. The voltage reducing device 11 steps the AC voltage down since DC-powered devices generally operate at a lower voltage (e.g., less than 12 volts) than commercially-supplied AC power (e.g., 120 volts). Next, the rectifier 12 converts the lower voltage level AC voltage to a pulsating DC voltage. The pulsating DC voltage is then filtered and regulated by the filter 13 and the regulator 14, respectively, to produce a relatively smooth DC voltage level."), FIG. 1 (showing known AC-DC converter).) Furthermore, even if the electronic device does not use 120V AC directly, a person of ordinary skill in the art would have understood that the AC voltage can be adjusted by using a transformer, similar to as disclosed in *Zhang*, to a voltage suitable for the electronic device to be powered. (Ex. 1022, ¶[0083] ("The 120 VAC or 220 VAC power from the commercial line is reduced to 9 VAC by the transformer 31 …"); Ex. 1013, 161-162, 165-166.)

134. A person of ordinary skill in the art would thus have been motivated, with a reasonable expectation of success, to configure the second device in the *Birrell-Logan* combination (claim 1) to be adapted to receive power from a power supply connected to an AC mains for reasons above and those discussed in claim 3 (Section IX.A.2). (*See* above Section IX.A.2.) Such a skilled person would have

had a reasonable expectation of success implementing this feature given that use of 120V AC from the electrical grid and use of a transformer to convert the AC power a different voltage were well known. (Ex. 1022, ¶[0083]; Ex. 1013, 161-162, 165-166.) The above configuration would have been a mere combination of known components and technologies, according to known methods, to produce predictable results.

135. The *Birrell-Logan-Zhang* combination discloses this limitation **in another way**. As discussed below for claim 21, a person of ordinary skill in the art would have been motivated to include a rechargeable battery ("power supply") in the modified lighting tile 50, where the battery is charged by AC mains power during normal operation, and when the AC mains power is interrupted, the battery powers the modified lighting tile 50. (*See* below at Section IX.C.2.) Accordingly, for those reasons, the modified lighting tile 50 ("second device") in the *Birrell-Logan-Zhang* combination would have been adapted to **receive power from a rechargeable battery (a "power supply")** that is charged by an AC mains ("a power supply connected to an AC mains").

2. Claim 21

136. As I discussed for claim 21 above, the *Birrell-Logan* combination discloses/suggests the limitations of claim 21. (*See* above at Section IX.A.14.)

137. Furthermore, I have been asked to consider a scenario in which the *Birrell-Logan* combination is read not to disclose that "the first device" includes "at least one battery" as explained for claim 21 above. Under that scenario, in my opinion, a person of ordinary skill in the art would have been motivated to implement a battery in the modified tile 50 ("first device") in the *Birrell-Logan* combination in view of *Zhang*.

138. Like *Birrell*, *Zhang* discloses a power supply providing power to LEDs. (Ex. 1022, ¶¶[0082]-[0084].) *Zhang* additionally discloses "a battery 55," where the power supply derives from the 120V AC power to charge the battery during normal operations and when the AC power is interrupted, battery 55 provides power to the LEDs. *(Id.,* ¶¶[0082]-[0087], FIG. 2.1; *see also id.*, Abstract, ¶¶[0036], [0054], [0094], [0109].)

Declaration of R. Jacob Baker, Ph.D., P.E.
U.S. Patent No. 10,966,298

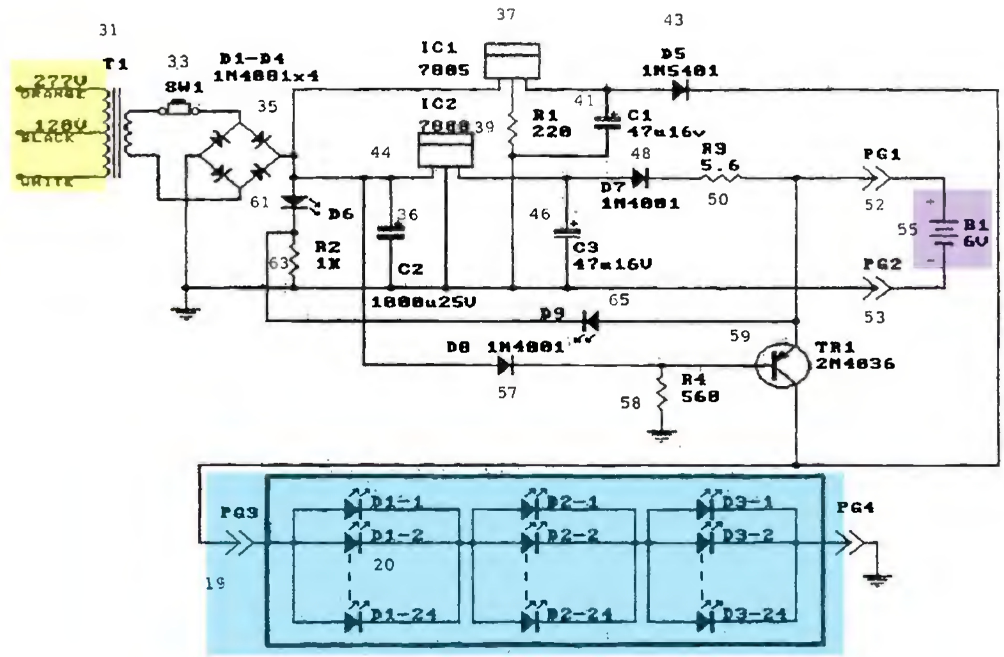


Fig. 2.1, Electronic Circuit Board for LED Exit Sign

(Ex. 1022, FIG. 2.1 (120V AC in yellow, LEDs 19 in blue, and battery 55 in purple).)

139. A person of ordinary skill in the art would have found it straightforward and beneficial to include a rechargeable battery in the modified lighting tile 50 of the *Birrell-Logan* combination that would be charged using AC mains power (e.g., 120/220 VAC), during normal operation. Consistent with that described in *Zhang*, a person of ordinary skill in the art would have found it beneficial to include such a battery as it would have provided backup power to the apparatus, which ultimately ensures that the LEDs in lighting tile 50 would provide continuous illumination, particularly during emergency situations, e.g., fire and earthquake, when the AC

mains power is not available. (Ex. 1022, ¶¶[0082]-[0087]; *see also id.*, ¶[0036] ("During power interruption, the battery becomes the power supply for the LED board."); *see also* Section IX.C.1 (discussing that the modified lighting tile 50 is adapted to receive power from a power supply connected to an AC mains).) Furthermore, a person of ordinary skill in the art would have been motivated to use a rechargeable battery as it would have allowed repeated uses and charges by use of the AC power when available. (Ex. 1022, ¶[0036] ("The circuit design allows the LED board to use 120 VAC or 220 VAC line power and charge the battery.").)

140. A person of ordinary skill in the art would have had the capability, and a reasonable expectation of success, in implementing a rechargeable battery in a system like the *Birrell-Logan* combination, given that it was known to use such a battery as a portable power and/or backup power and that associated circuit design was also known. (*See*, *e.g.*, Ex. 1011, FIG. 7 (disclosing a wireless device that includes a battery, i.e., micro-cell array); Ex. 1022, FIG. 2.1 (disclosing circuit diagram for a lighting device that includes a rechargeable battery).) Such implementation would have involved applying known technologies (e.g., known lighting device (like the *Birrell-Logan*) and known technology for storing energy (like *Zhang*)) according to known methods (e.g., implementing a rechargeable battery in a lighting device) to yield the predictable result of implementing a

rechargeable battery in a lighting device, e.g., for use as a backup power when the main power is interrupted.

3. Claims 10-12

141. As I discussed above for **claim 10**, the *Birrell-Logan* combination discloses claim 10. (*See* above at Section IX.A.4.) As discussed below, the combination modified in view of *Zhang* also discloses/suggests claim 10.

142. While Section IX.A.4(c) explains how *Birrell* discloses a "power supply" as claimed, a person of ordinary skill in the art would have been motivated to configure the modified tile 50 in the *Birrell-Logan* "apparatus" (explained in Section IX.A.4) to include a rechargeable battery ("power supply") to provide power to the apparatus in view of *Zhang* as discussed in claim 21 above. (*See* above at Section IX.C.2.) Further, for similar reasons and in light of the state of the art, a person of ordinary skill in the art would have been motivated to configure such a rechargeable battery to also be **recharged wirelessly** ("said power supply is configured to provide power to the apparatus and is configured to **receive power wirelessly from a power source**") to provide additional versatility and benefits known to be achieved through such features. Such a skilled person would have appreciated that enabling the rechargeable battery in the modified tile 50 to be charged wirelessly (and via AC mains (*see* above at Sections IX.C.1-2; Ex. 1022, ¶[0036] ("The circuit design allows the LED board to use 120 VAC or 220 VAC

line power and charge the battery."))) would have provided a user friendly and efficient way of sustaining power to the rechargeable battery in the *Birrell-Logan-Zhang* modified tile 50 discussed above. Indeed, it was known in the art that wirelessly recharging mechanisms/configurations for devices (including portable devices) provided benefits to existing devices (including portable ones) (Ex. 1112, 1:7-57, 7:5-8:10; Ex. 1092, ¶¶[0198]-[0200] (disclosing that "[a] power facility 1800," which is integrated into a lighting system, "may include a battery" where "power facility 1800 can include an inductive charging facility" to "charge an onboard power source").) A person of ordinary skill in the art would have thus found providing such features with the rechargeable battery in the *Birrell-Logan-Zhang* modified tile 50 beneficial as it would have provided alternate ways to maintain the battery life. A person of ordinary skill in the art would have had the same capabilities and expectation of success to implement such features as described above for modifying tile 50 to include a rechargeable battery. (Section IX.C.2.) Indeed, as I have explained in the Sections above, *Birrell* provides guidance on the wireless transfer of power. Accordingly, the modified tile 50 ("apparatus") would have predictably resulted in having a rechargeable battery ("power supply") configured to provide power to the apparatus and to receive power wirelessly from a power source (e.g., the source providing power to wirelessly send power to the battery).

143. **Claim 11** ("The apparatus of claim 10, wherein said circuit is configured to detect contact with the conductive substance via capacitive sensing") is disclosed/suggested by the *Birrell-Logan-Zhang* combination for the same reasons explained in Section IX.A.5.

144. As to **claim 12** ("The apparatus of claim 10, wherein said apparatus is configured to receive power from an AC mains power supply"), as I discussed above, *Birrell* and *Logan* discloses/suggests this limitation. (*See* above at Section IX.A.6.) I have been asked to consider a scenario in which the *Birrell* is read not to disclose or suggest this limitation, however. Under that scenario, in my opinion, *Birrell* in view of *Logan* and *Zhang* discloses this limitation for the reasons I discussed above for claims 3 and 21 above. (*See* above at Sections IX.C.1-2.)

145. Moreover, a person of ordinary skill in the art would have been motivated to configure the modified tile 50 in the *Birrell-Logan-Zhang* combination discussed above for claim 10 (Section IX.C.3) to receive power from an AC mains power supply for reasons similar to those explained for claims 3 and 21 above (Sections IX.C.1-2) and claim 10 (Section IX.C.3). For similar reasons, a person of ordinary skill in the art would have been motivated (and had similar expectation of success in implementing a configuration) to allow the rechargeable battery in the modified tile 50 to be wirelessly charged (e.g., power provided via the AC mains) to ensure the rechargeable battery would be able to serve as a backup power supply for

extended periods of AC main power interruptions. Thus, the combination discloses an "apparatus is configured to receive power from an AC mains power supply."

D. *Birrell* in view of *Logan* and *Sembhi* Discloses and/or Suggests the Features of Claim 5

146. In my opinion, *Birrell* in view of *Logan* and *Sembhi* discloses and/or suggests all of the features of claim 5 of the '298 patent.

1. Claim 5

a) The apparatus of claim 1, wherein said second device comprises a three-way switch.

147. *Birrell* in view *Logan* and *Sembhi* discloses and/or suggests this limitation. *Birrell* discloses that that lighting tile 50 includes "integrally embedded electronic manual controls such as touch switches or light level controls, remote controls such as radio frequency or infra-red, automatic controls" (Ex. 1005, 8:4-30), but *Birrell* does not expressly disclose that lighting tile 50 includes a "three-way switch." Nevertheless, a person of ordinary skill in the art would have been motivated to implement such feature in the modified tile 50 of the *Birrell-Logan* combination in view of *Sembhi*.

148. Similar to *Birrell*, *Sembhi* discloses a lighting device controller, e.g., a switch, for controlling the light intensity level. (Ex. 1008, Abstract.) As such, a person of ordinary skill in the art would have had reason to consider the teachings of *Sembhi* when implementing the system of *Birrell*. *Sembhi* discloses that it was known to implement three-way switches, which allows an additional light control

"at another location." (Ex. 1008, ¶[0018].) *Sembhi* explains that such a three-way switch would also allow using radio frequency signals to control the lighting.

149. A person of ordinary skill in the art would have been motivated to implement a three-way switch in the modified tile 50 of the *Birrell-Logan* combination to allow the device to provide or work with three-way switch designs that allow a user to control the lighting device from multiple locations. Indeed, the use of three-way switches to allow a user to control lighting devices from different locations was known to a person of ordinary skill in the art at the time, and providing similar functionalities with the lighting tile 50 of the *Birrell-Logan* apparatus would have been a straightforward and predictable application of such common technologies and features. (Ex. 1019, 1:11-18; Ex. 1023, 3:66-4:10 (disclosing use of two three-way switches to control a lighting device), 5:12-32 (same); FIG. 4.) Given such knowledge, a person of ordinary skill in the art would have been motivated to implement a three-way switch at the modified lighting tile 50 that would operate with another three-way switch at a location different from the lighting tile, to provide similar functionality (e.g., allow a user to turn on/off tile 50 from different locations).

150. A person of ordinary skill in the art would have the capability and reasonable expectation of success in implementing a three-way switch in a system like the *Birrell-Logan* combination, given that implementing three-way switches for

lighting circuits was "well known." (Ex. 1019, 1:11-18; Section V.A (e.g., ¶37).) Indeed, *Birrell* itself discloses that the lighting device can be controlled remotely using radio frequency, similar to as disclosed in *Sembhi*. (Ex. 1005, 8:4-14; Ex. 1011, ¶[0018].)

E. *Birrell* Discloses the Features of Claims 6, 18, and 24

151. In my opinion, *Birrell* discloses all of the features of claims 6, 18, and 24 of the '298 patent.

1. Claim 6

a) A method of operating an apparatus, the method comprising:

152. I understand that this phrase is the preamble of claim 6, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitations in the preamble. *Birrell* discloses this preamble for similar reasons discussed above for claim limitations 1(a) and 10(a) (showing operation of lighting tile 50 or the lighting system with tile 50 (each an "apparatus"). (*See* above at Sections IX.A.1(a) and IX.A.4(a).) For example, *Birrell* discloses "systems and methods" for connecting an electrical device, e.g., lighting tile 50, to power sources. (Ex. 1005, 2:3-5; *see also id.*, Abstract, 2:36-3:16 ("connecting an electrical device to a power source, the system providing for an electrical coupling between the electrical device and an energised surface associated with the power source"), 16:37-18:13, FIGS. 1-3 and 8.) Furthermore and as discussed below, *Birrell* discloses that tile 50 receives power and data wirelessly, detects contacts with capacitive sensing, and is capable of increasing a level of power to an LED circuit comprising at least one LED in the apparatus after detection of the contact. (*See* below at Sections IX.E.1(b)-(e).)

b) receiving power wirelessly in the apparatus;

153. *Birrell* discloses this limitation. For example, *Birrell* discloses that lighting tile 50 receives power wirelessly through capacitive coupling. *Birrell* discloses with reference to Figure 8 a device with an AC power supply that is capacitively coupled to tile 50 and transmits wireless power to tile 50 via capacitors C_A and C_B to ultimately power LEDs 59. (Ex. 1005, FIGS. 1 and 8, 2:36-3:16, 3:17-27 (device "coupled to the power source without requiring any direct connection"), 14:26-15:33 (disclosing with reference to FIG. 1 that tile 50 includes LEDs 59), 20:26-31; 21:34, 22:29-30 ("a 48 Volt AC power supply of 80kHz will satisfactorily illuminate the LED's of Figure 8"), 23:2-11).)

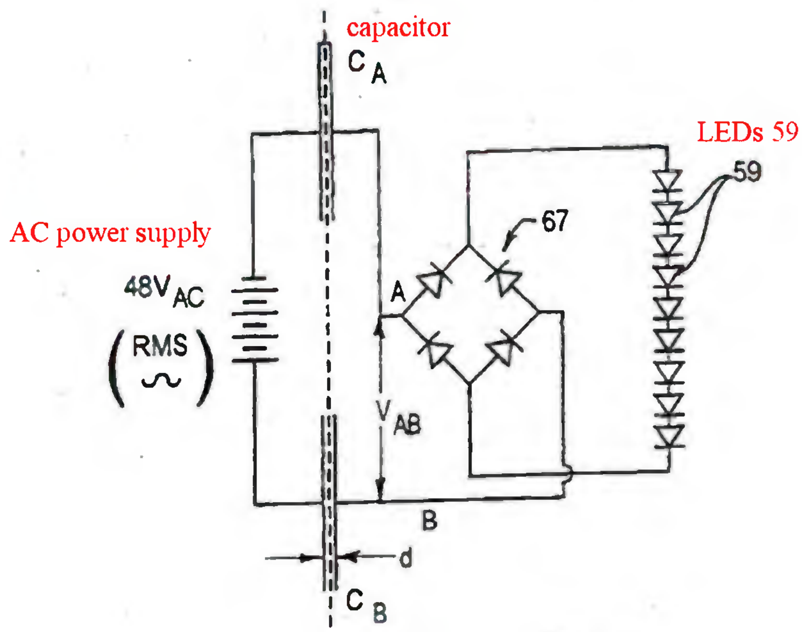


FIG 8

(Ex. 1005, FIG. 1 (annotated to show AC power capacitively coupled to LEDs 59 through capacitors C_A and C_B).) Thus, such functionality discloses the step recited in claim limitation 6(b).

c) transmitting or receiving data signals wirelessly;

154. *Birrell* discloses this limitation. For example, *Birrell* discloses that the device including the power supply transmits both data and power wirelessly and lighting tile 50 receives the same. (Ex. 1005, 8:31-9:10 ("**provid[ing] both data and power through the electrical coupling** ...."), 9:11-29, 13:15-23 ("lighting elements may be controlled by data transmitted with the power supply"), 23:15-21 ("all data is transferred by the same electrical path that is used for the electrical

power transfer," where "data is superpositioned on the primary power.").) Accordingly, *Birrell* discloses this limitation. (*See also* Section IX.E.1(b).)

d) detecting contact with a conductive substance via capacitive sensing; and

155. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 1(c)(2), which describes the operations of detecting such contact like that claimed in limitation 6(d) in relation to the touch sensor component in lighting tile 50. (*See* above at Section IX.A.1(c)(2).)

e) increasing a level of power to an LED circuit comprising at least one LED in the apparatus after detection of the contact.

156. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 10(b) (reciting "an LED circuit comprising at least one LED") and claim 14 (reciting "power is provided to said plurality of LEDs after said circuit detects the contact with the conductive substance"). (*See* above at Sections IX.A.4(b) and IX.A.8.) Consistent with that explained in those sections, by providing power to the LED circuit (and LEDs) after contact detection, the level of power is increased to the LED circuit to illuminate the LEDs in a manner consistent with *Birrell*'s disclosures and that recited in limitation 6(e). (Sections IX.A.4(b) and IX.A.8.)

2. Claim 18

a) An apparatus comprising:

157. I understand that this phrase is the preamble of claim 18, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitations in the preamble. *Birrell* discloses this preamble for the same reasons discussed above for claim limitation 10(a) (tile 50 being an "apparatus"). (*See* above at Section IX.A.4; *see also* Section IX.A.11; *see* below at Sections IX.E.2(b)-(d).)

b) a flat planar substrate upon which is mounted a plurality of LEDs;

158. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 13(b), which explains how tile 50 ("apparatus") includes the claimed "flat planar substrate" like that recited in limitation 18(b). (*See* above at Section IX.A.7(b).)

c) a transmission conductor configured to provide data and power to said apparatus; and

159. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 18(c). (*See* above at Section IX.A.11(c).)

d) a data receiver, wherein the data receiver is configured to receive the data from the transmission conductor or an antenna and the power from the transmission conductor.

160. *Birrell* discloses this limitation. As I discussed for claim limitation 18(d) in Section IX.A.11(d), *Birrell* discloses the claimed "data receiver" as data demodulator 81 of tile 50. (*See* above at Section IX.A.11(d).) Also as discussed, *Birrell* discloses a "transmission conductor" in tile 50 providing both data and power to the "data receiver." (Section IX.A.11(d); *see also* Ex. 1005, FIG. 9.) For example, *Birrell* discloses that "the light tile circuitry is structured so that **all data is transferred by the same electrical path that is used for the electrical power transfer**" (Ex. 1005, 23:15-21), where data are transmitted using a data modulator 80 and received using a data demodulator 81 ("data receiver") (*id.*, 23:22-29).

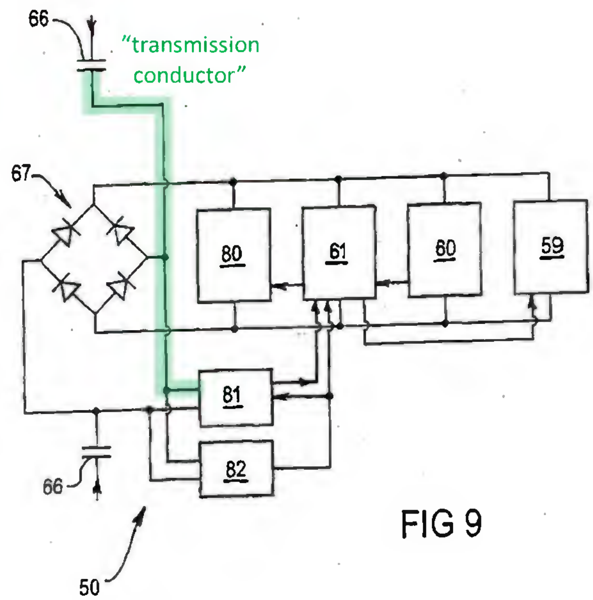


FIG 9

(Ex. 1005, FIG. 9 (annotated to show the transmission conductor).) Thus, *Birrell* discloses a data receiver (demodulator 81) configured to receive the data from the transmission conductor and the power from the transmission conductor, as claimed.

3. Claim 24

a) The method of claim 6, wherein the conductive substance includes a metallic material.

161. *Birrell* discloses this limitation for the same reasons discussed above for claim 23. (*See* above at Section IX.A.15.)

F. *Birrell* in view of *Logan* and *Camras* Discloses and/or Suggests the Features of Claims 7, 8 and 25

162. In my opinion, *Birrell* in view of *Logan*, and *Camras* discloses and/or suggests all of the features of claims 7, 8 and 25 of the '298 patent.

1. Claim 7

a) An apparatus comprising:

163. I understand that this phrase is the preamble of claim 7, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitations in the preamble. *Birrell* discloses this preamble for the same reasons discussed above for claim limitation 10(a) (describing tile 50 as an "apparatus"). (*See* above at Section IX.A.4(a); *see* below at Sections IX.F.1(b)-(g).)

b) an LED circuit including a plurality of LEDs;

164. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 10(b). (*See* above at Section IX.A.4(b).)

c) a data receiver, wherein the data receiver is configured to receive data from an antenna;

165. *Birrell* in view of *Logan* discloses this limitation for the same reasons discussed above for claim 10(e). (*See* above at Section IX.A.4(e).)

d) a first circuit configured to detect contact with a conductive substance via capacitive sensing for at least controlling the LED circuit;

166. *Birrell* discloses this limitation for the same reasons discussed above for claim limitations 1(c)(2) and 10(d). (*See* above at Sections IX.A.1(c)(2), IX.A.4(d).)

e) a second circuit having a transmission conductor and an inductor, wherein the second circuit is configured to use at least the inductor to receive power wirelessly for powering the apparatus; and

167. *Birrell* in view of *Logan* discloses and/or suggests this limitation for the same reasons discussed above for claim limitations 1(b) and 1(c)(3) (explaining how the modified tile 50 in the *Birrell-Logan* combination would include a circuit having a transmission conductor and inductor like that recited in limitation 7(e). (*See* above at Sections IX.A.1(b), IX.A.1(c)(3).)

f) a lens doped with particles configured to transmit light,

168. The *Birrell-Logan* combination in view of *Camras* discloses this limitation. *Birrell* discloses that a front cover of lighting tile 50 may be an optical lens (Ex. 1005, 16:27-36) and that certain coatings/layers may be applied to the LED to change the color of the light (*id.*, 12:4-21), but *Birrell* does not expressly disclose that the lens is "doped with particles configured to transmit light." Nevertheless, a person of ordinary skill in the art would have been motivated to implement such feature in the *Birrell-Logan* combination in view of *Camras*.

169. Like *Birrell*, *Camras* discloses an LED lighting device. (Ex. 1009, Abstract.) As such, a person of ordinary skill in the art would have had reason to consider the teachings of *Camras* when implementing the system of *Birrell*. *Camras* further discloses that "conventional phosphor particles" may be used to dope optical lenses of LEDs to "convert[]" light of wavelengths emitted … to other wavelengths." (Ex. 1009, ¶[0054]; *see also id.*, ¶[0059].) *Camras* teaches doping the LED lens with particles (e.g., phosphor) to transmit lights of different colors, similar to as described in the '298 patent. (Ex. 1001, 14:13-19 ("lens may be coated or doped with a phosphor or nano-particle that would produce a change in the color or quality of light emitted from the device 10 through the lens 34.").)

170. A person of ordinary skill in the art when implementing *Birrell* (as modified above) would have been motivated to look to *Camras*, as both *Birrell* and *Camras* disclose that phosphor can be applied to an LED device to change its color. (Ex. 1005, 12:4-21 (*Birrell* disclosing that "[t]he phosphor coating may be directly applied on to the LED. In an alternative form, the lighting element includes a phosphor layer disposed at or adjacent to the first major surface of the lighting element."); Ex. 1009, ¶¶[0054], [0059] ("conventional phosphor particles" may be used to dope optical lenses of LEDs to "convert[]" light of wavelengths emitted … to other wavelengths").) In light of such knowledge and *Camras*'s disclosure of doping the lens with phosphor particles, a person of ordinary skill in the art would

have been motivated to configure the LED lighting components of the modified tile 50 to include a lens doped with particles to transmit light (similar to the guidance provided by *Camras*) as it would have resulted in use of known LEDs (manufactured and provided based on known processes (*Camras*)) to provide different light colors. Indeed, a person of ordinary skill in the art would have understood that using a doped lens with the LED components in *Birrell* would have been one of several predictable design choices given it was known that the light has to travel through such a lens before being observed and that *Birrell* discloses that its lens may provide "an optical correction for emitting light … or other applied optical techniques." (Ex. 1005, 16:27-36.)

171. A person of ordinary skill in the art would have had the capability, and a reasonable expectation of success, in implementing the above modification because the use of phosphor particles for modifying LED light color was well-known and commercially available. (Ex. 1092, ¶[0195] ("a phosphor may be used to convert UV or blue radiation coming out of a light source 300 into broader band illumination, such as white illumination" and "packages such as those used for one-watt, three-watt, five-watt and power packages offered by manufacturers such as LumiLeds, Nichia, Cree and Osram-Opto.").) Such implementation would have involved applying known technologies (e.g., known LED lighting device (like *Birrell*) and techniques to introduce phosphor particles in LED lighting device (like

Camras)) according to known methods (e.g., use of phosphor particles on LED lenses) to yield the predictable result of providing LEDs of different colors by doping the lens of the LEDs.

g) wherein the apparatus is portable.

172. *Birrell* discloses this limitation for the same reasons discussed above for claim 17(e). (*See* above at Section IX.A.10(e).)

2. Claim 8

a) The apparatus of claim 7, wherein said apparatus is configured to provide power to said LED circuit after detection of a touch.

173. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 10(b) (describing that tile 50 in *Birrell* discloses a "LED circuit" including, e.g., LEDs 59) and claim 14. (*See* above at Sections IX.A.4(b) and IX.A.8.)

3. Claim 25

a) The apparatus of claim 7, wherein the conductive substance includes a metallic material.

174. *Birrell* discloses this limitation for the same reasons discussed above for claim 23. (*See* above at Section IX.A.15.)

G. *Birrell* in view of *Logan* and *Gleener* Discloses and/or Suggests the Features of Claim 9

175. In my opinion, *Birrell* in view of *Logan* and *Gleener* discloses and/or suggests all of the features of claim 9 of the '298 patent.

1. Claim 9

a) An apparatus comprising:

176. I understand that this phrase is the preamble of claim 9, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitations in the preamble. *Birrell* discloses this preamble for the same reasons discussed above for claim limitation 10(a). (*See* above at Section IX.A.4(a); *see* below at Sections IX.G.1(b)-(f).)

b) an LED circuit including at least one LED;

177. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 10(b). (*See* above at Section IX.A.4(b).)

c) a data receiver, wherein the data receiver is configured to receive data from an antenna;

178. *Birrell* in view of *Logan* discloses this limitation for the same reasons discussed above for claim limitation 10(e). (*See* above at Section IX.A.4(e).)

d) a capacitor coupled to the antenna, wherein the capacitor is configured to tune the antenna; and

179. While the *Birrell-Logan* combination does not explicitly disclose a capacitor coupled to the disclosed antenna to tune the antenna (*see* Section

IX.A.4(e)), a person of ordinary skill in the art would have been motivated to configure the *Birrell-Logan* combination to implement such features in view of *Gleener*.

180. *Birrell* discloses that "data communication between devices … may be achieved by means of wireless techniques." (Ex. 1005, 8:4-30; *see also id.*, 8:31-9:10.) Like *Birrell*, *Gleener* relates to using antennas for wireless communication (Ex. 1010, Abstract, ¶[0002]) and thus a person of ordinary skill in the art would have found it relevant to consult the teachings of *Gleener* when implementing the *Birrell-Logan* combination, which includes an antenna for wireless power/data transmission. (*See* above at Section IX.A.4(e).)

181. *Gleener* discloses with reference to Figure 1 a known matching network 10 that includes a capacitor 18, where the capacitor is coupled to an antenna 14 to "tune … the antenna" for transmitting wireless signals at a single prescribed frequency bandwidth. (Ex. 1010, ¶[0005].)

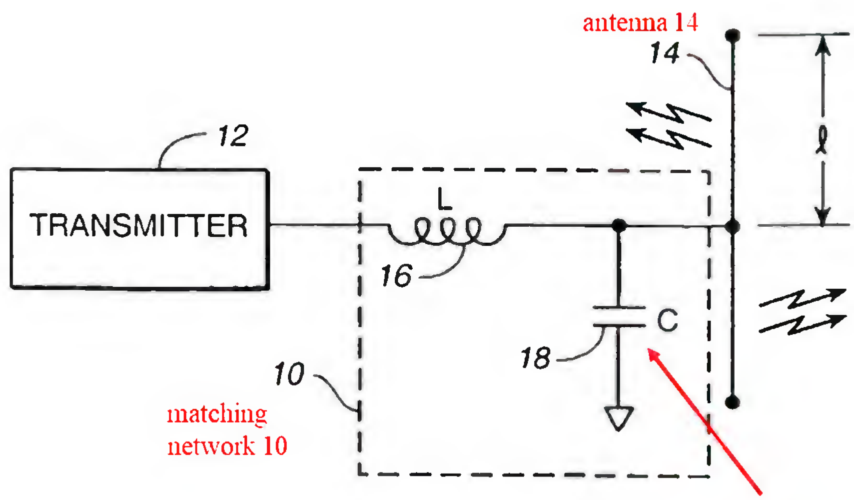


FIG._1
(PRIOR ART)

(Ex. 1010, FIG. 1 (annotated to show matching network 10, capacitor 18, and antenna 14).) With references to Figure 3, *Gleener* similarly discloses a matching network 104 that includes a variable capacitor 108, where the capacitor is coupled to antenna 106 "to tune the antenna system 100" for transmitting wireless signals at two separate frequency bandwidths. (*Id.*, ¶[0022]; *see also id.*, Abstract, ¶¶ [0013]-[0014], [0021], [0024].)

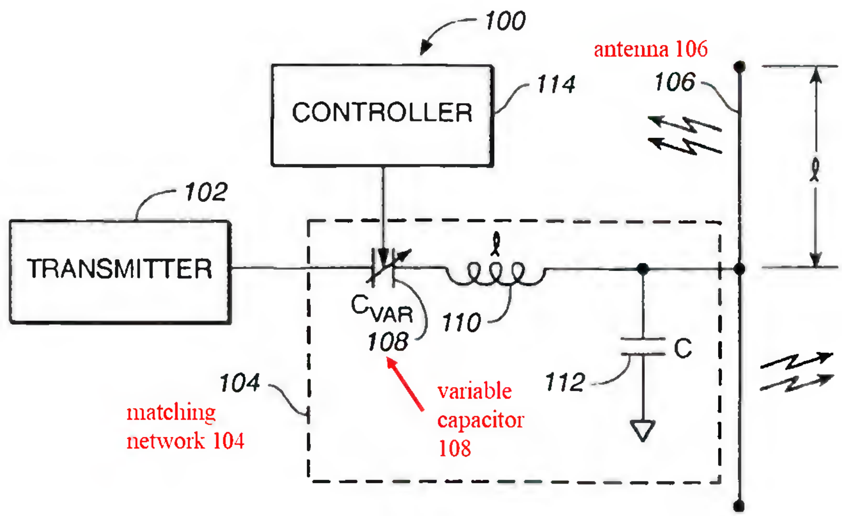


FIG._3

(*Id.*, FIG. 3 (annotated to show matching network 104, variable capacitor 108, and antenna 106); *see also id.*, ¶¶[0021]-[0022] (describing Figure 3).) Consistent with that disclosed in *Gleener*, a person of ordinary skill in the art would have understood that tuning an antenna by using a capacitor (such as those included in a matching network and discussed above) may apply to antennas used in both transmitters and receivers. (Ex. 1010, ¶¶[0012], [0020], [0022], [0025]-[0026]; Section V.A (e.g., ¶32).)

182. In light of *Gleener*'s disclosures, a person of ordinary skill in the art would have been motivated, and found it predictable, to configure the *Birrell-Logan* combination such that a capacitor is coupled to its antenna for tuning the same. As

disclosed in *Gleener*, "[i]n order to assure the **maximum transfer of energy** …, the **impedances** between the antenna and the transmitter for the frequency of transmission **should be matched**." (Ex. 1010, ¶[0002].) Thus, a person of ordinary skill in the art would have found it beneficial to use a matching network that includes a capacitor, where the capacitor is coupled to antenna for tuning the same, similar to as disclosed in *Gleener*, for transmitting or receiving wireless signals at one or more frequency bandwidths. (*Id.*, ¶[0020] ("It will be recognized by those of ordinary skill in the art that the transceiver 100 may also be a receiver or a transmitter depending upon the specific application."); *see also id.*, ¶¶ [0005], [0020]-[0022], FIGS. 1 and 3.)

183. Furthermore, such a skilled person would have recognized that such a configuration enables an antenna to be precisely tuned to a frequency at which wireless transmissions occur, and also to enables it to be tuned to one of multiple frequencies, which increases the versatility and efficiency of the antenna. (*Id.*, ¶¶[0011] ("enables … efficiently transmit[ting] signals"), [0014] ("[T]he variable capacitor has a first capacitance value corresponding to the first frequency to be tuned and a second capacitance value corresponding to the second frequency to be tuned.").)

184. A person of ordinary skill in the art would have had a reasonable expectation of success implementing this feature. For example, such a skilled person

would have known that such a configuration was already known and therefore was feasible. (Ex. 1016, 2:62-65 ("a multiple band antenna assembly wherein at least one of the frequency bands is selectively **tunable** by manual control or electrically **tunable variable capacitor** element"), 4:49-55 ("FIG. 5 illustrates one possible capacitive tuning network 71 for use with the antenna assembly 20 …. Capacitive tuning element 158 may be a varactor element."); Abstract (disclosing a "capacitive tuning network" that "include[s] … an adjustable capacitor"); Ex. 1026, 31-32 (disclosing that it was known to use a "variable capacitor … for tuning a…receiver").) *Gleener* discloses that the capacitor value in the matching network can be determined using "methods known in the art for impedance matching" (Ex. 1010, ¶[0025]) and that the disclosed impedance matching features may apply to "different type[s] of antenna structure" (*id.*, ¶[0027] ("modifications and improvements of the present invention may also be apparent to those of ordinary skill in the art such as using a different type of antenna structure")). As such, the above configuration would have been a mere combination of known components and technologies (e.g., an antenna as in the *Birrell-Logan* combination, and an adjustable capacitor for tuning the antenna, as in *Gleener*), according to known methods, to produce predictable results.

e) a transmission conductor configured to wirelessly receive an alternating electromagnetic field that is used to provide power to charge the apparatus,

185. *Birrell* in view of *Logan* discloses this limitation. For example, as I discussed in Section IX.A.1(c)(3), an inductor and an electrically conductive wire ("transmission conductor") receive the wirelessly transmitted power to power the LEDs. (Section IX.A.1(c)(3).) Such wireless power is transmitted/received in the form of an "alternating electromagnetic flux" (the claimed "wirelessly receiv[ing] an alternating electromagnetic field that is used to provide power"). (Ex. 1006, 3:19-5:4, 6:12-14 ("transmitted electromagnetic signal"), 7:20-26 ("electromagnetic field transmitted by the transmission coil"); FIGS. 1-2.)

186. Additionally, *Birrell* discloses that lighting tile 50 includes "energy storage components." (Ex. 1005, 15:34-16:10.) I have been asked to consider a scenario in which the "energy storage components" are read not to be chargeable. Under that scenario, in my opinion, a person of ordinary skill in the art would have been motivated for the energy storage components to be a rechargeable battery that is provided the power discussed above in order to be charged. A person of ordinary skill in the art would have recognized that choosing between a rechargeable and non-rechargeable battery would have been a choice between a finite number of predictable options, and that rechargeable batteries were known to be used for wirelessly received power. (*See, e.g.*, Ex. 1011, 3:23-34 (disclosing that wirelessly

received "power can then be fed into a trickle charger for charging a power storage device, such as batteries, in wireless and other electrical devices"); Ex. 1022, ¶¶[0085]-[0087] (disclosing use of a rechargeable battery to power LEDs when the main power is interrupted).) Thus, in my opinion, a person of ordinary skill in the art would have been motivated to implement a rechargeable battery because it would have been one of a few known and predictable ways to implement an energy storage. And a person of ordinary skill in the art would have recognized that use of a rechargeable battery would have been preferable for ease of use and in light of the fact that power is being received by the device in *Birrell*, and thus would have been motivated to implement the same. A person of ordinary skill in the art would have recognized that it would have been inefficient not to make use of a rechargeable battery given the receipt of wireless power in *Birrell*. Furthermore, such a skilled person would have had a reasonable expectation of success in implementing the energy storage components in *Birrell* as a rechargeable battery that is provided with power by the transmission conductor in *Birrell* given that the proposed modification would have been a simple and straightforward change involving known components. As such, *Birrell* (as modified by *Logan*) teaches or suggests an inductor and an electrically conductive wire ("transmission conductor") configured to wirelessly receive an alternating electromagnetic field that is used to provide power to charge the apparatus, as claimed.

f) wherein the apparatus is portable.

187. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 17(e). (*See* above at Section IX.A.10(e).)

H. *Birrell* in view of *Logan* and *Rahmel* Discloses and/or Suggests the Features of Claim 16

188. In my opinion, *Birrell* in view of *Logan* and *Rahmel* discloses and/or suggests all of the features of claim 16 of the '298 patent.

1. Claim 16

a) An apparatus comprising:

189. I understand that this phrase is the preamble of claim 16, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitations in the preamble. *Birrell* discloses this preamble for the same reasons discussed above for claim limitation 10(a). (*See* above at Section IX.A.4(a) ; *see* below at Sections IX.H.1(b)-(f).)

b) an LED circuit comprising at least one LED;

190. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 10(b). (*See* above at Section IX.A.4(b).)

c) a data receiver, wherein the data receiver is configured to receive data from a first antenna;

191. *Birrell* in view of *Logan* discloses this limitation for the same reasons discussed above for claim limitation 10(e). (*See* above at Section IX.A.4(e).)

d) a second antenna configured to receive radio frequency noise, wherein said radio frequency noise is used to provide power to said apparatus; and

192. *Birrell* in view of *Logan* and *Rahmel* discloses this limitation. While the *Birrell-Logan* combination discloses "a first antenna," it does not expressly

disclose "a second antenna" configured as claimed. Nevertheless, a person of ordinary skill in the art would have been motivated to implement this feature in view of *Rahmel*.

193. Like *Birrell* and *Logan*, *Rahmel* discloses a wireless power system, and thus a person of ordinary skill in the art would have had reason to consider the teachings of *Rahmel*. (Ex. 1011, 1:7-13.) *Rahmel* discloses using an energy reclamation system (ERS) antenna to receive ambient RF noise and convert the same to power a device and/or to charge a battery therein. (*Id.*, 1:52-2:20, FIG. 7.) Such ERS antenna may be implemented in addition to an existing antenna. (*Id.*, 9:56-10:15 (describing a "dual-antenna design," where "one for energy harvesting at a desired frequency band and one for performing RF communication at a different frequency band."), FIGS. 6 and 11.)

194. A person of ordinary skill in the art would have been motivated to implement an ERS antenna in a system similar to the *Birrell-Logan* combination. For example, *Rahmel* explains that with separate antennas (i.e., an ERS antenna and the original antenna), they can be "designed with different dimensions to receive signals at their respectively desired frequency bands." (Ex. 1011, 10:1-4; *see also id.*, 6:59-64, 9:56-10:15.) *Rahmel* discloses that a design using multiple antennas would have allowed efficient energy transfer. (*Id.*, 6:41-48 ("If the EHS includes an array of antennas, each antenna in the array can be designed to have maximum

efficiency at the same or different bands of frequency from one another.").) Furthermore, a dedicated ERS antenna would have allowed it to be placed in a location where the noise signal is strong in order to maximize the amount energy collected. (*Id.*, 6:64-7:4.)

195. Additionally, *Rahmel* discloses that the energy collected via an ERS antenna from the noise may be stored in an energy storage subsystem (ESS), such as a rechargeable battery, to provide emergency backup power. (Ex. 1011, 3:14-42, 5:26-50, 9:48-11:8, FIGS. 7 and 11.) Thus, for the above reasons, a person of ordinary skill in the art would have found it beneficial to implement an ERS antenna ("second antenna") (and an accompanying rechargeable battery for storing power).

196. A person of ordinary skill in the art would have understood that such a modification would have allowed the *Birrell-Logan* apparatus to benefit from efficient wireless communications over various frequencies and dedicated functionalities to improve operations of the apparatus (e.g., use of antennas for receiving power/data over different frequencies, receiving power to charge/power certain components (e.g., energy storage components, other components), etc.). A person of ordinary skill in the art would have considered the design trade-offs of including multiple antennas in the apparatus with the advantages and improved efficiencies, as suggested by *Rahmel*.

197. A person of ordinary skill in the art would have the capability and reasonable expectation of success in implementing an ERS antenna in a system similar to the *Birrell-Logan* combination, given that *Rahmel* explains that the design and implementation of an ERS antenna can be flexible based on any physical size limitations, and the technology available. (Ex. 1011, 2:37-42 ("These selected frequency bands [to collect the energy of the noise] are not required to be contiguous and may based on the operational environment, the application, any physical size limitations, and the technology available to cost effectively integrate an ERS into a device or application.").) Such implementation would have involved applying known technologies (e.g., known wireless transmission system (like the *Birrell-Logan*) and known technology for collecting energy from RF noise (like *Rahmel*)) according to known methods (e.g., use of ERS antenna) to yield the predictable result of providing multiple antennas in the combined apparatus, while achieving the benefits of receiving/providing efficient wireless power based on RF noise to power the apparatus and/or to charge the battery therein. In my opinion, a person of ordinary skill in the art would have considered the design trade-offs of using the receiving coil in the *Birrell-Logan* combination as a mechanism to receive data and power with providing separate antenna for receiving power, and in light of the guidance by *Rahmel*, would have been motivated to implement the latter for the reasons and benefits I have discussed above. The resulting modification would have

further contemplated adjustments for transmitting/receiving such power wirelessly and contemplated the necessary adjustment to the device providing the power in the modified *Birrell* system discussed above.

e) a circuit configured to detect contact with a user via capacitive sensing for at least controlling the LED circuit,

198. *Birrell* discloses this limitation for the similar reasons discussed above for claim limitations 1(c)(2) and 10(d) and that its capacitive touch sensor is capable of "human touch sensing" ("detect contact with a user").. (*See* above at Sections IX.A.1(c)(2) and IX.A.4(d); Ex. 1005, 16:18-26 (touch sensor "acts as a high impedance capacitive pick up for human touch sensing.").)

f) wherein said apparatus is portable.

199. *Birrell* discloses this limitation for the same reasons discussed above for claim limitation 17(e). (*See* above at Section IX.A.10(e).)

I. *Birrell* in view of *Logan* and *Sontag* Discloses and/or Suggests the Features of Claim 22

200. In my opinion, *Birrell* in view of *Logan*, and *Sontag* discloses and/or suggests all of the features of claim 22 of the '298 patent.

1. Claim 22

a) A system comprising:

201. I understand that this phrase is the preamble of claim 22, and I have been asked to assume that the preamble limits the claim. Under that assumption, it is my opinion that *Birrell* discloses the limitations in the preamble. *Birrell* discloses this preamble for the similar reasons discussed above for claim limitation 1(a) and claim 21. (*See* above at Sections IX.A.1(a) and IX.A.14 ; *see* below at Sections IX.I.1(b)-(d).) For example, *Birrell* discloses "a system for connecting an electrical device to a power source." (Ex. 1005., 2:36-3:16, 3:17-27; *see also* Ex. 1005, Abstract, 16:37-18:13, FIGS. 1-3 and 8.)

b) a transmit device, wherein the transmit device is configured to transmit power and signals; and

202. *Birrell* in view of *Logan* discloses this limitation for similar reasons discussed above for claim limitation 1(b) and claim 4. (*See* above at Sections IX.A.1(b) and IX.A.3.) For example, the *Birrell-Logan* combination discloses that a device (including, e.g., 48V AC power supply and a transmitting coil) transmits

both power and signals/data wirelessly ("a transmit device"). (Ex. 1005, 8:31-9:10 ("The arrangement of being able to **provide both data and power through the electrical coupling** ...."), 9:11-29, 13:15-23, 23:15-21.)

c) a data communications device, wherein the data communications device includes (a) at least one LED, (b) at least one antenna, and (c) at least one data communications circuit,

203. *Birrell* in view of *Logan* discloses this limitation. For example, the my analysis above for limitation 21(b) explains how the *Birrell-Logan* combination discloses a modified lighting tile 50 (which is part of a lighting system and is a "data communication device" of limitation 22(c)) that includes LEDs 59 ("at least one LED"), a receiving coil ("at least one antenna"), and a "data communications circuit," like that recited in limitation 22(c). (*See* above at Section IX.A.14(b).)

d) wherein the transmit device is configured to transmit power and signals wirelessly to the data communications device using resonance and inductance.

204. *Birrell* in view of *Logan* and *Sontag* discloses this limitation. As I discussed in claim limitation 1(b) and claim 4, the *Birrell-Logan* combination discloses a device including a power supply ("transmit device") that transmits power and data ("power and signals") wirelessly to lighting tile 50 ("data communications device") based on inductive coupling via a transmitting coil ("using ... inductance"). (*See* above at Sections IX.A.1(b) and IX.A.3.) While the *Birrell-Logan* combination

does not expressly disclose transmitting power and signals wirelessly to the data communications device using both "resonance and inductance," a person of ordinary skill in the art would have been motivated to implement such features in view of *Sontag*.

205. Like *Birrell* and *Logan*, *Sontag* discloses a wireless transmission system that may be used to transmit signal and electrical energy across a barrier, and thus a person of ordinary skill in the art would have has reason to consider *Sontag*'s teachings and/or suggestions in light of the *Birrell-Logan* combination. (Ex. 1012, 1:8-12, 1:29-33, 5:56-6:23 ("[a] signal transmission system for use in transmitting a signal across a barrier").) *Sontag* further discloses that its system utilizes a "transmitting antenna [that] consists of a **resonant LC circuit** involving **inductor** 22 and **capacitor** 24" and a "receiving antenna 20 also comprises an LC circuit consisting of inductor 26 and capacitor 28." (Ex. 1012, 3:2-13, FIGS. 1-3; *see also id.*, 3:14-4:21.) The '298 patent refers to an inductor as an "inductance." (*See*, *e.g.*, Ex 1001, 24:57 and FIG. 57 (referring to an inductor 2130 in FIG. 57 as a "lump inductance 2130"); *see also id.* 26:24-28 and FIG. 63 (referring to an inductor 2196 in FIG. 65 as a "lump inductance 2196").) As such, *Sontag* discloses a wireless transmission system "using resonance and inductance" as claimed. Based on the teachings/suggestions of *Birrell*, *Logan*, *Sontag*, and a person of ordinary skill in the art's knowledge, such a skilled person would have been motivated to modify the

Birrell-Logan combination in view of *Sontag*'s teachings ("transmit device" in limitation 22(b)) to transmit power and signals wirelessly to the data communications device "using resonance and inductance."

206. A person of ordinary skill in the art would have been motivated to use both resonance and inductance to perform wireless transmission, similar to as taught by *Sontag*, because, as expressly disclosed by *Sontag*, such configuration makes a wireless transmission system's "transfer characteristic … relatively independent of the distance," "radial misalignment," and "resonant frequency mismatch" between the transmitting resonant antenna and the receiving resonant antenna. (Ex. 1012, 2:12-19; *see also id.*, 5:37-48.) As such, "signal level at the receiver [is] **virtually constant over a much wider range of distance variations** between the transmitting antenna and the receiving antenna, both axially and laterally." (Ex. 1012, 2:31-34; *see also id.*, 2:35-43, 4:50-5:48, FIGS. 4-5.) A person of ordinary skill in the art would have understood that this is beneficial as it would have allowed wireless transmission over a broader range of operating distance between the antennas and thus would have also provided flexibility as to the configuration and implementation of the wireless transmission system. (*Id.*, 1:34-47 (describing that in a prior art system "spacing between the transmitter and receiver is … carefully adjusted to be the distance at which 'critical coupling' occurs."), 3:24-28 (describing that *Sontag*'s

configuration allows spacing between antennas different from the critical spacing distance).)

207. A person of ordinary skill in the art would have had the capability, and a reasonable expectation of success, in implementing *Sontag*'s teachings in the *Birrell-Logan* combination, given that both relate to wireless transmission systems and that use of inductance and resonance in electrical circuits were well known. (Ex. 1013, 56 ("The term inductance-capacitance (LC circuit refers to any of various combinations of inductors and capacitors. The most common LC circuits are resonant circuits, impedance-matching networks and selective filters)"), 57-59; Section V.A (e.g., ¶¶32-34).) Additionally, *Sontag* explains that its wireless transmission system is not limited to the disclosed examples and can be implemented using "various other combinations of capacitive and inductive elements," which "can be formed to comprise a resonant circuit such as, and including, the series combination of an inductor and a capacitor." (Ex. 1012, 3:7-14.) Such implementation would have involved applying known technologies (e.g., known wireless transmission system (like *Birrell* and *Logan*) and wireless transmission using both inductance and resonance (like *Sontag*)) according to known methods (e.g., use of inductors and capacitors to perform wireless transmission) to yield the predictable result of providing wireless transmission with a broad range of operating distance and thus flexibility in system configuration and implementation.

X. CONCLUSION

208. I declare that all statements made herein of my knowledge are true, and that all statements made on information and belief are believed to be true, and that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

Dated: September 5, 2021

By: R. J. Baker

R. Jacob Baker, Ph.D., P.E.

R. JACOB (JAKE) BAKER, PH.D., P.E.

Intellectual Property Consultant
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PROFESSIONAL SUMMARY

Russel Jacob (Jake) Baker, Ph.D., P.E. (IEEE Student Member 1983, Member 1988, Senior Member 1997, and Fellow 2013) was born in Ogden, Utah, on October 5, 1964. He received the B.S. and M.S. degrees in electrical engineering from the University of Nevada, Las Vegas, in 1986 and 1988. He received the Ph.D. degree in electrical engineering from the University of Nevada, Reno in 1993. His Google Scholar profile is here and his ResearchGate profile is here.

From 1981 to 1987 he served in the United States Marine Corps Reserves (Fox Company, 2nd Battalion, 23rd Marines, 4th Marine Division). From 1985 to 1993 he worked for E. G. & G. Energy Measurements and the Lawrence Livermore National Laboratory designing nuclear diagnostic instrumentation for underground nuclear weapons tests at the Nevada Test Site. During this time, he designed, and oversaw the fabrication and manufacture of, over 30 electronic and electro-optic instruments including high-speed cable and fiber-optic receiver/transmitters, PLLs, frame- and bit-syncs, data converters, streak-camera sweep circuits, Pockels cell drivers, micro-channel plate gating circuits, and analog oscilloscope electronics. From 1991-1992 he was an adjunct faculty member in the department of electrical engineering at the University of Nevada, Las Vegas (UNLV). From 1993 to 2000 he served on the faculty in the department of electrical engineering at the University of Idaho (UI), first as an untenured Assistant Professor and then from 1998 as a tenured Associate Professor. In 2000 he joined a new electrical and computer engineering (ECE) program at Boise State University (BSU) where he was promoted to Full Professor in 2002. He then served as the ECE department chair at BSU from 2004 to 2007. At BSU he helped establish graduate programs in ECE including, in 2006, the university's second PhD degree. In 2012 he re-joined the faculty at UNLV as a tenured Full Professor of ECE. During his service at the UI, BSU, and UNLV he has been the major professor to more than 100 graduate students. In addition to this industry and academic experience, he has done consulting, both technical and expert witness, for over 125 companies and laboratories.

Over the last 35+ years his research/development interests and publications have been, or currently are, focused on: analog-to-digital/digital-to-analog data conversion and transmission, optoelectronics (imagers, displays, LIDARs, APDs, SiPMs, and associated electronics), analog and digital integrated circuit design and fabrication, design of diagnostic electrical and electro-optic instrumentation for scientific research, integrated electrical/biological circuits and systems, array (memory, imagers, and displays) fabrication and design, CAD tool development and online tutorials, low-power interconnect and packaging (electrical and optical) techniques, design of wired/wireless communication and interface circuits, circuit design for the use and storage of renewable energy, power electronics and power supply design, and the delivery of online engineering education.

Dr. Baker is the named inventor on over 150 US patents. He is a member of the honor societies Eta Kappa Nu and Tau Beta Pi, a licensed Professional Engineer, a popular lecturer that has delivered over 50 invited talks around the world, an IEEE Fellow, and the author of the books CMOS Circuit Design, Layout, and Simulation, CMOS Mixed-Signal Circuit Design, and a coauthor of DRAM Circuit Design: Fundamental and High-Speed Topics. He received

the 2000 Best Paper Award from the IEEE Power Electronics Society, the 2007 Frederick Emmons Terman Award, the 2011 IEEE Circuits and Systems Education Award and the 2021 Wiley-IEEE Press Textbook Award for the 4th Edition of his book CMOS Circuit Design, Layout, and Simulation.

His service activities include the IEEE Press Editorial Board (1999-2004), editor for the Wiley-IEEE Press Book Series on Microelectronic Systems (2010-2018), the Technical Program Chair of the 2015 IEEE 58th International Midwest Symposium on Circuits and Systems (MWSCAS 2015), the IEEE Solid-State Circuits Society (SSCS) Administrative Committee (2011-2016), Distinguished Lecturer for the SSCS (2012-2015), Technology Editor (2012-2014) and Editor-in-Chief (2015-2020) for the IEEE Solid-State Circuits Magazine, IEEE Kirchhoff Award Committee (2020-present), and advisor for the student branch of the IEEE at UNLV (2013-present).

INDUSTRY EXPERIENCE

2013 - present: Working with Freedom Photonics, Santa Barbara, CA, on the integration, fabrication and design, of optoelectronics with CMOS integrated circuits. Work includes the design of compact optical transceivers for range finding applications, high-efficiency integrated silicon avalanche photodetectors for quantum key receivers, Geiger mode SiGe receivers for long-range communications, cryptography, and the fabrication of near-infrared focal plane arrays. Packaging and testing of numerous chips fabricated in both CMOS and SiGe technologies using LEDs, ILDs, PIN, APDs, and ROICs.

2009 - present: Expert witness in intellectual property disputes in electrical, electro-optic, and computer engineering matters for: 1) district court and ITC patent disputes, 2) inter partes reviews at the PTAB, and 3) arbitrations and mediations.

2017 - 2019: Worked with Vorpal Research Systems, Las Vegas, NV on the design of integrated circuit electronics and optoelectronics for optical transceivers used in LIDARs/LADARs.

2016 - 2019: Worked with Attollo Engineering on the design of transient digitizers for the capture of high-speed signals for range finders using LEDs and lasers in compact optical transceivers.

2013 - 2018: Working with Mission Support and Test Services, LLC (MSTS, formerly National Security Technologies, LLC, [NSTec]) on the Design and Fabrication of Integrated electrical/photonic application specific integrated circuit (ASIC) design for use in the implementation of diagnostic instrumentation.

2013 - 2015: Consultant for OmniVision. Working on integrating CMOS image sensors (CIS) with memory for very high-speed consumer imager products. Design specialty DRAM, high-speed interfaces between CIS and DRAM, packaging techniques to pair the CIS with DRAM.

2010 - 2013: Worked with Arete' Associates on the design of high-speed compressive transimpedance amplifiers for LADAR projects and the design of ROIC unit cells. Work funded by the U. S. Air Force.

2013: Cirque, Inc. Consulting on the design of analog-to-digital interfaces for capacitive touch displays and pads.

2012: Consultant at Lockheed-Martin Santa Barbara Focal Plane Array. CMOS circuit design and fabrication for the development and manufacture of infrared components and imaging systems with an emphasis on highest sensitivity Indium Antimonide (InSb) focal plane arrays (FPAs) in linear through large staring formats. Product groups include FPAs, integrated dewar assemblies (IDCAs), camera heads, high-speed interfaces between image processors and imaging systems, and infrared imaging systems.

2010 - 2012: Working with Aerius Photonics (and then FLIR Inc. when Aerius was purchase by FLIR) on the design of Focal Plane Arrays funded (SBIRs and STTRs) by the U.S. Air Force, Navy, and Army. Experience with readout integrated circuits (ROICs) and the design/layout of photodetectors in standard CMOS.

2009 - 2010: Sun Microsystems, Inc. (and then Oracle) VLSI research group. Provided consulting on memory circuit design/fabrication and proximity connection (PxC) interfaces to DRAMs and SRAMs for lower power, 3D packaging, for memory modules and controllers implemented with FPGAs and custom ASICs.

2009 - 2010: Contour Semiconductor, Inc. Design of NMOS voltage and current references as well as the design of a charge pump for an NMOS memory chip.

1994 - 2008: Affiliate faculty (Senior Designer), Micron Technology. Designed CMOS circuits for DRAMs including DLLs, PLLs for embedded graphics chips, voltage references and regulators, data converters, field-emitting display drivers, sensing for MRAM (using delta-sigma data conversion topologies), SRAMs, RFIDs, CMOS active pixel

imagers and sensors, power supply design (linear and switching), input buffers, etc. Worked on a joint research project between Micron and HP labs in magnetic memory fabrication and design using the MTJ memory cell. Worked on numerous technologies ranging from LED lighting to medical imaging using CMOS image sensors (too many to list) resulting in numerous US patents (see following list). Considerable experience working with product engineering to ensure high-yield from the production line from fabrication to test. Co-authored a book on DRAM circuit design through the support of Micron. Gained knowledge in the entire memory design process from fabrication to packaging. Developed, designed, and tested circuit design techniques for multi-level cell (MLC) Flash memory using signal processing.

January 2008: Consultant for Nascentric located in Austin, TX. Provide directions on circuit operation (DRAM, memory, and mixed-signal) for fast SPICE circuit simulations.

May 1997 - May 1999: Consultant for Tower Semiconductor, Haifa, Israel. Designed CMOS integrated circuit cells for various modem chips, interfaces, and serial buses including USB circuits, charging circuits based upon power up/down circuits using an MOS or bandgap reference, pre-amplifiers, comparators, etc.

Summer 1998: Consultant for Amkor Wafer Fabrication Services, Micron Technology, and Rendition, Inc., Design PLLs and DLLs for custom ASICs and a graphics controller chip.

Summers 1994 - 1995: Micron Display Inc. Designing phase locked loop for generating a pixel clock for field emitting displays and a NTSC to RGB circuit on chip in NMOS. These displays are miniature color displays for camcorder and wrist watch size color television. Worked on the fabrication and design of video peripheral circuits for these displays.

September - October 1993: Lawrence Berkeley Laboratory. Designed and constructed a 40 A, 2 kV power MOSFET pulse generator with a 3 ns rise-time and 8 ns fall-time for driving Helmholtz coils.

Summer 1993: Lawrence Livermore National Laboratory, Nova Laser Program. Researched picosecond instrumentation, including time-domain design for impulse radar and imaging.

December 1985 - June 1993: (from July 1992 to June 1993 employed as a consultant while finishing up my Ph.D.), E.G.&G. Energy Measurements Inc., Nevada, Senior Electronics Design Engineer. Responsible for the design and manufacturing of instrumentation used in support of Lawrence Livermore National Laboratory's Nuclear Test Program. Responsible for designing and fabricating over 30 electronic and electro-optic instruments including: CCD camera design, communication networks, fiber optic transmitters employing high speed laser drive electronics, receivers employing envelop tracking for DC voltage restoration and regeneration of received information, receiver low noise amplifier design, frame synchronizers for re-assembling transmitted images, high-speed SRAM memory system design with battery back-up, calibration equipment design such as a tunnel diode pulse generator for testing compensation of oscilloscopes and DAC design for calibrating CCD readout electronics, power supply and battery charger designs, sweep circuits for streak cameras, Pockel's cell drive electronics, vertical amplifier design using HBTs for analog oscilloscopes used at the Nevada Test Site, and 10 kV ramp designs using a planar triode to name some of the designs.

This position provided considerable fundamental grounding in EE with a broad exposure ranging from the design of PC boards to, for example, the design of cable equalizers. Summarizing, gained experience in circuit design technologies including: bipolar, vacuum tubes (planar triodes for high voltages), hybrid integrated circuit fabrication and design, GaAs (high speed logic and HBTs), Mach-Zehnder interferometers, Pockels cells, krytrons, power MOSFETs, microwave techniques, power supplies, fiber optic transmitters/receivers, etc.

Summer 1985: Reynolds Electrical Engineering Company, Las Vegas, Nevada. Gained hands on experience in primary and secondary power system design, installation and trouble-shooting electric motors on mining equipment.

ACADEMIC EXPERIENCE

January 1991 - Present: Professor of Electrical and Computer Engineering at the **University of Nevada, Las Vegas** from August 2012 to present. From January 2000 to July 2012 held various positions at **Boise State University** including: Professor (2003 – 2012), Department Chair (2004 - 2007), and tenured Associate Professor (2000 - 2003). From August 1993 to January 2000 was a tenured/tenure track faculty member at the **University of Idaho**: Assistant Professor (1993 - 1998) and then tenured Associate Professor (1998 - 2000). Lastly, from January 1991 to May

1993 held adjunct faculty positions in the departments of Electrical Engineering at the University of Nevada, Las Vegas and Reno. Additional details:

- Research is focused on analog and mixed-signal integrated circuit fabrication and design. Worked with multi-disciplinary teams (civil engineering, biology, materials science, etc.) on projects that have been funded by EPA, DARPA, NASA, Army, DMEA, Navy, and the AFRL.
- Current and past research and development interests are:
  - Design and packaging of electrical/optical systems (e.g., LiDARs/LADARs) using LEDs, semiconductor lasers, lens for focusing and directing light, integrated circuits, and associated control and communication systems/circuits.
  - Capacitive sensing techniques using delta-sigma modulation and interfacing to sensors
  - Design of high-voltage and energy switching circuits
  - Circuit design and fabrication for the control, use, and storage of renewable energy using thermoelectric generators
  - Design of electrical/biological/optical circuits and systems using electrowetting on dielectric for automating and controlling biological experiments
  - Design of readout integrated circuits (ROICs) for use with focal plane arrays (FPAs)
  - Heterogeneous integration of III-V photonic devices (e.g., FPAs and VCSELs) with CMOS
  - Methods (e.g., 3D packaging and capacitive interconnects) to reduce power consumption in semiconductor memories, memory modules, and digital systems using custom and non-custom (e.g., FPGAs) implementations
  - Analog and mixed-signal circuit fabrication and design for communication systems, synchronization, energy storage, data conversion, and interfaces
  - The design of writing and sensing circuitry for emerging nonvolatile memory technologies, focal planes, and displays (arrays) in nascent nanotechnologies (e.g., magnetic, chalcogenide)
  - Reconfigurable electronics design and fabrication using nascent memory technologies such as the memristor to implement FPGAs
  - Finding an electronic, that is, no mechanical component, replacement for the hard disk drive using nascent fabrication technologies
  - Power electronics circuit design for consumers and consumer electronics including power management and adaptive control to reduce power consumption
  - Design of bandpass delta-sigma modulators for IQ demodulation in wireless communication systems in OFDM, WiFi, 802.11, Bluetooth, 3G, 4G, etc.
  - University prototyping, fabricating, and packaging of integrated circuits
- Led, as chair, the department in graduate curriculum (MS and PhD), program development, and ABET accreditation visits.
- Worked with established and start-up companies to provide technical expertise and identify employment opportunities for students.
- Held various leadership and service positions including: ECE chair, graduate coordinator, college curriculum committee (chair), promotion and tenure committee, scholarly activities committee, faculty search committee, university level search committees, etc. Collaborate with College of Engineering faculty on joint research projects.
- Taught courses in circuits, analog IC design, digital VLSI design and fabrication, fiber optics, and mixed-signal integrated circuit design to both on- and, via the Internet, off-campus students. Research emphasis in integrated circuit design using nascent technologies.

EDUCATION

- Ph.D. in Electrical Engineering; December 1993; University of Nevada, Reno, GPA 4.0/4.0. Dissertation Title: *Applying power MOSFETs to the design of electronic and electro-optic instrumentation*.
- M.S. and B.S. in Electrical Engineering: May 1986 and May 1988; University of Nevada, Las Vegas. Thesis Title: *Three-dimensional simulation of a MOSFET including the effects of gate oxide charge*.

MEMBERSHIPS IN PROFESSIONAL AND SCHOLARLY ORGANIZATIONS

IEEE (student, 1983; member, 1988; senior member, 1997; Fellow, 2013)
Member of the honor societies Eta Kappa Nu and Tau Beta Pi
Licensed Professional Engineer

HONORS AND AWARDS

- Consolidated Students of the University of Nevada, Las Vegas (CSUN) Faculty Award, 2017
- Tau Beta Pi UNLV Outstanding Professor of the Year in 2013, 2014, 2015 and 2016
- UNLV ECE Department Distinguished Professor of the Year in 2015
- IEEE Fellow for contributions to the design of memory circuits - 2013
- Distinguished Lecturer for the IEEE Solid-State Circuits Society, 2012 - 2015
- IEEE Circuits and Systems (CAS) Education Award - 2011
- Twice elected to the Administrative Committee of the Solid-State Circuits Society, 2011 - 2016
- Frederick Emmons Terman Award from the American Society of Engineering Education - 2007
- President's Research and Scholarship Award, Boise State University - 2005
- Honored Faculty Member - Boise State University Top Ten Scholar/Alumni Association 2003
- Outstanding Department of Electrical Engineering faculty, Boise State 2001
- Recipient of the IEEE Power Electronics Society's Best Paper Award in 2000
- University of Idaho, Department of Electrical Engineering outstanding researcher award, 1998-99
- University of Idaho, College of Engineering Outstanding Young Faculty award, 1996-97

SERVICE

Reviewer for IEEE transactions on solid-state circuits, circuits and devices magazine, education, instrumentation, nanotechnology, VLSI, etc. Reviewer for several American Institute of Physics journals as well (Review of Scientific Instruments, Applied Physics letters, etc.) Board member of the IEEE press (reviewed dozens of books and book proposals). Reviewer for the National Institutes of Health. Technology editor and then Editor-in-Chief for the Solid-State Circuits Magazine.

Led the Department on ABET visits, curriculum and policy development, and new program development including the PhD in electrical and computer engineering. Provided significant University and College service in infrastructure development, Dean searches, VP searches, and growth of academic programs. Provided university/industry interactions including starting the ECE department's advisory board. Held positions as the ECE department Master's graduate coordinator and coordinator for the Sophomore Outcomes Assessment Test (SOAT).

Also currently serves, or has served, on the IEEE Press Editorial Board (1999-2004), as a member of the first Academic Committee of the State Key Laboratory of Analog and Mixed-Signal VLSI at the University of Macau, as editor for the Wiley-IEEE Press Book Series on Microelectronic Systems (2010-2018), on the IEEE Solid-State Circuits Society (SSCS) Administrative Committee (2011-2016), as an Advisory Professor to the School of Electronic and Information Engineering at Beijing Jiaotong University, as a Distinguished Lecturer for the SSCS (2012-2015), as the Technical Program Chair for the IEEE 58th 2015 International Midwest Symposium on Circuits and Systems, MWSCAS 2015, as advisor for the student branch of the IEEE at UNLV (2013-present), and as the Technology Editor (2012-2014) and Editor-in-Chief (2015-2020) for the *IEEE Solid-State Circuits Magazine*, and IEEE Kirchhoff Award Committee (2020-present).

ARMED FORCES

6 years United States Marine Corps reserves (Fox Company, 2nd Battalion, 23rd Marines, 4th Marine Division), Honorable Discharge, October 23, 1987. Military Occupational Specialty was Machine Gunner (MOS 0331)

TEXTBOOKS AUTHORED

Baker, R. J., "CMOS Circuit Design, Layout and Simulation, Fourth Edition" *Wiley-IEEE Press*, 1234 pages. ISBN 9781119481515 (2019) **Over 50,000 copies of this book in print.** (Third Edition published in 2010, Revised Second Edition published in 2008, and Second Edition Published in 2005)

Baker, R. J., "CMOS Mixed-Signal Circuit Design," *Wiley-IEEE*, 329 pages. ISBN 978-0470290262 (second edition, 2009) and ISBN 9780471227540 (First Edition published in 2002)

Keeth, B., Baker, R. J., Johnson, B., and Lin, F., "DRAM Circuit Design: Fundamental and High-Speed Topics", *Wiley-IEEE*, 2008, 201 pages. ISBN: 9780470184752

Keeth, B. and Baker, R. J., "DRAM Circuit Design: A Tutorial", *Wiley-IEEE*, 2001, 201 pages. ISBN 0780360141

Baker, R. J., Li, H.W., and Boyce, D.E. "CMOS Circuit Design, Layout and Simulation," *Wiley-IEEE*, 1998, 904 pages. ISBN 9780780334168

BOOKS, OTHER (edited, chapters, etc.)

Saxena, V. and Baker, R. J., "Analog and Digital VLSI," chapter in the CRC Handbook on Industrial Electronics, edited by J. D. Irwin and B. D. Wilamowski, *CRC Press*, 2009 second edition.

Baker, R. J., "CMOS Analog Circuit Design," (A self-study course with study guide, videos, and tests.) IEEE Education Activity Department, 2000. ISBN 0-7803-4822-2 (with textbook) and ISBN 0-7803-4823-0 (without textbook)

Baker, R. J., "CMOS Digital Circuit Design," (A self-study course with study guide, videos, and tests.) *IEEE Education Activity Department*, 2000. ISBN 0-7803-4812-5 (with textbook) and ISBN 0-7803-4813-3 (without textbook)

Li, H.W., Baker, R. J., and Thelen, D., "CMOS Amplifier Design," chapter 19 in the CRC VLSI Handbook, edited by Wai-kai Chen, *CRC Press*, 1999 (ISBN 0-8493-8593-8) and the second edition in 2007 (ISBN 978-0-8493-4199-1)

INVITED TALKS AND SEMINARS

Have given over 50 invited talks and seminars at the following locations: AMD (Fort Collins), AMI semiconductor, Arizona State University, Beijing Jiaotong University, Boise State University, Carleton University, Carnegie Mellon, Columbia University, Dublin City University (Ireland), E.G.&G. Energy Measurements, Foveon, the Franklin Institute, Georgia Tech, Gonzaga University, Hong Kong University of Science and Technology, ICSEng Keynote, ICySSS keynote, IEEE Computing and Communication Workshop (CCWC), IEEE Electron Devices Conference (NVMTS), IEEE Workshop on Microelectronics and Electron Devices (WMED), Indian Institute of Science (Bangalore, India), Instituto de Informatica (Brazil), Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM, Mexico), Iowa State University, Lawrence Livermore National Laboratory, Lehigh University, Lockheed-Martin, Micron Technology, Nascentric, National Semiconductor, Princeton University, Rendition, Saintgits College (Kerala, India), Southern Methodist University, Sun Microsystems, Stanford University, ST Microelectronics (Delhi, India), Temple University, Texas A&M University, Tower Semiconductor (Israel), University of Alabama (Tuscaloosa), University of Arkansas, University of Buenos Aires (Argentina), University of Houston, University of Idaho, University of Illinois (Urbana-Champaign), Université Laval (Québec City, Québec), University of Macau, University of Maryland, Université de Montréal (École Polytechnique de Montréal), Xilinx (Ireland), University of Nevada (Las Vegas), University of Nevada (Reno), University of Toronto, University of Utah, Utah State University, and Yonsei University (Seoul, South Korea).

RESEARCH FUNDING (LAST 5 YEARS AS A PROFESSOR)

Recent funding listed below. In-kind, equipment, and other non-contract/grant funding [e.g., MOSIS support, money for travel for invited talks, etc.] not listed.

- Goldman, J., Menezes, J., and Baker, R. J., (2021) "Monitored Compression Therapy: Using Smart Technology to Optimize the Treatment of Lower Extremity Swelling," UNLV Sports Research & Innovation Initiative. Proof of Concept Grant Program, $50,000
- Baker, R. Jacob, (2019-2021) "Tiled Silicon Photomultiplier Array Read-Out Integrated Circuit," NASA, $225,238
- Baker, R. Jacob, (2019-2021) "Dual-Mode, Extended Near-Infrared, Focal Plane Arrays Fabricated with CMOS Compatible GeSiSn Alloy Materials," DARPA, $149,998
- Baker, R. Jacob, (2018-2020) "Geiger Mode SiGe Receiver for Long-Range Optical Communications," NASA, $99,996
- Baker, R. Jacob, (2019) "Improved Quantum Efficiency Photo-Detector," Navy, $29,999
- Baker, R. Jacob, (2018-2019) "Tiled Silicon Photomultiplier Array Read-Out Integrated Circuit – Phase I," NASA, $29,999

- Baker, R. Jacob, (2017-2019) "Quantum Cryptography Detector Chip," Defense MicroElectronics Activity (DMEA), $266,029
- Baker, R. Jacob, (2017-2019) "Advanced Printed Circuit Board Design Methods for Compact Optical Transceiver," U.S. Army/DOD, $299,605
- Baker, R. Jacob, (2016-2018) "High-Sensitivity Monolithic Silicon APD and ROIC," U.S. Air Force/DOD, $299,665
- Baker, R. Jacob, (2017-2018) "Transimpedance Amplifier Integrated Circuit Collaboration," Department of Energy, National Security Technologies, LLC, $100,436
- Baker, R. Jacob, (2017) "Geiger Mode SiGe Receiver for Long-Range Optical Communications," NASA, $30,000
- Baker, R. Jacob, (2016-2017) "Testing and development of BiCMOS photodetectors and diagnostic instrumentation," Department of Energy, National Security Technologies, LLC, $181,605
- Baker, R. Jacob, (2016-2017) "Dual-Mode, Extended Near Infrared, Focal Plane Arrays fabricated with a Commercial SiGe BiCMOS Process," DARPA, $41,892

DOCTORAL STUDENT SUPERVSION

11. Mario Valles Montenegro (underway)
10. Sachin Namboodiri – A Multi-channel MCP-PMT based Readout Integrated Circuit for LiDAR Applications (2020)
9. Wenlan Wu – High-Speed Radhard Mega-Pixel CIS Camera for High-Energy Physics (2019)
8. Kostas Moutafis – A Highly-Sensitive Global-Shutter CMOS Image Sensor with On-Chip Memory for Hundreds of kilo-frames per second Scientific Experiments (2019)
7. Yiyan Li – Portable High Throughput Digital Microfluidics and On-Chip Bacteria Cultures (2016)
6. Yacouba Moumouni – Designing, Building, and Testing a Solar Thermoelectric Generation, STEG, for Energy Delivery to Remote Residential Areas in Developing Regions (2015)
5. Qawi IbnZayd Harvard – Low-Power, High-Bandwidth, and Ultra-Small Memory Module Design (2011)
4. Vishal Saxena – K-Delta-1-Sigma Modulators for Wideband Analog-to-Digital Conversion (2010)
3. Robert Russell Hay – Digitally-Tunable Surface Acoustic Wave Resonator (2009)
2. Xiangli Li (the first Boise State University College of Engineering PhD graduate) – MOSFET Modulated Dual Conversion Gain CMOS Image Sensors (2008)
1. Feng Lin, Research and Design of Low Jitter, Wide Locking-Range Phase-Locked and Delay-Locked Loops (2000)

MASTERS STUDENT SUPERVISION

92. Armani Alvarez (underway)
91. Chris Barr (underway)
90. Jazmin Boloor (underway)
89. Minsung Cho (underway)
88. Francisco Mata-carlos (underway)
87. David Santiago (underway)
86. Daniel Senda (underway)
85. James Skelly (underway)
84. Khulan Tsogt (underway)
83. Gonzalo Arteaga – Current-mode photon-counting circuit with SiGe BiCMOS input stage (2020)
82. Jason Silic – Design and Fabrication of a 6-bit Current-Mode ADC for Lidar and High-Speed Applications (2020)
81. Brandon Wade (2020)
80. Mario Valles Montenegro – Front-End CMOS Transimpedance Amplifiers on a Silicon Photomultiplier Resistant to Fast Neutron Fluence (2020)
79. Jonathan DeBoy (2018)
78. Dane Gentry – Design, Layout, and Testing of SiGe APDs Fabricated in a BiCMOS Process (2018)
77. James Mellot – Variable Transition Time Inverters in a Digital Delay Line with Analog Storage for Processing Fast Signals and Pulses (2018)
76. Eric Monahan – High Speed Fast Transient Digitizer Design and Simulation (2018)
75. Shada Sharif – Design and Analysis of First and Second Order K-Delta-1-Sigma Modulators in Multiple Fabrication Processes (2018)

74. Vikas Vinayaka – Analysis and Design of Analog Front-End Circuitry for Avalanche Photodiodes (APD) and Silicon Photo-Multipliers (SiPM) in Time-of-Flight Applications (2018)
73. Claire Tsagkari – Design, Fabrication and Testing of a Capacitive Sensor Using Delta-Sigma Modulation (2017)
72. Kevin Buck – Fast Transient Digitizer and PCB Interface (2015)
71. Marzieh Sharbat Maleki (2015)
70. Angsuman Roy – Design, Fabrication and Testing of Monolithic Low-Power Passive Sigma-Delta Analog-to-Digital Converters (2015)
69. Daniel Anderson – Design and Implementation of an Instruction Set Architecture and Instruction Execution Unit for the RZ9 Coprocessor System (2014)
68. Jared Gordon – Design and Fabrication of an Infrared Optical Pyrometer ASIC (2013)
67. Justin Butterfield (2012)
66. Adam Johnson – Methods and Considerations for Testing Resistive Memories (2012)
65. Ben Millemon – CMOS Characterization, Modeling, and Circuit Design in the Presence of Random Local Variation (2012)
64. Justin Wood (2012)
63. Chamunda Ndinawe Chamunda (2011)
62. Gary VanAckern – Design Guide for CMOS Process On-Chip 3D Inductors using Thru-Wafer Vias (2011)
61. Lucien Jan Bissey – High-Voltage Programmable Delta-Sigma Modulation Voltage-Control Circuit (2010)
60. Kaijun Li (2010)
59. Yingting Li (co-supervised with Maria Mitkova) (2010)
58. Lael Matthews (co-supervised with Said Ahmed-Zaid) (2010)
57. Priyanka Mukeshbhai Parikh (2010)
56. Todd Plum (co-supervised with Jeff Jessing) – Design and Fabrication of a Chemicapacitive Sensor for the Detection of Volatile Organic Compounds (2010)
55. Rahul Srikonda (2010)
54. Avani Falgun Trivedi (2010)
53. Kuang Ming Yap – Gain and Offset Error Correction for CMOS Image Sensors using Delta-Sigma Modulation (2010)
52. Mahesh Balasubramanian – Phase Change Memory - Array Development and Sensing Circuits using Delta-Sigma Modulation (2009)
51. Lincoln Bollschweiler (2009)
50. Shantanu Gupta (2009)
49. Qawi Harvard – Wide I_O DRAM Architecture Utilizing Proximity Communication (2009)
48. Avinash Rajagiri (2009)
47. Ramya Ramarapu (2009)
46. Harikrishna Rapole (2009)
45. Aruna Vadla (2009)
44. Hemanth Ande (2008)
43. Curtis Cahoon – Low-Voltage CMOS Temperature Sensor Design using Schottky Diode-Based References (2008)
42. Prashanth Busa (2008)
41. John McCoy III (2008)
40. Dennis Montierth – Using Delta-Sigma-Modulation for Sensing in a CMOS Imager (2008)
39. Rudi Rashwand (2008)
38. Barsha Shrestha (co-supervised with Zhu Han) – Wireless Access in Vehicular Environments using Bit Torrent and Bargaining (2008)
37. Eric Becker – Design of an Integrated Half-Cycle Delay Line Duty Cycle Corrector Delay Locked Loop (2007)
36. Matthew Leslie – Noise-Shaping Sense Amplifier for Cross-Point Arrays (2007)
35. Jose Monje (2007)
34. Sanghyun Park (2007)
33. Vishal Saxena – Indirect Feedback Compensation Techniques for Multi-Stage Operational Amplifiers (2007)
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- Harvard, Q. I. and Baker, R. J., “Low-Power, High-Bandwidth, and Ultra-Small Memory Module Design,” a presentation covering semiconductor packaging, DRAM architectures, and I/O circuits. The goal of this work is to investigate replacing the currently used dual in-line memory modules (DIMMs) with a smaller and a lower power memory module, a “Nano-Module.”
- Baker, R. J., and Campbell, K. A., “Reconfigurable Analog Electronics using the Memristor.”
- Baker, R. J., and Saxena, V., “A K-Delta 1-Sigma Modulator for Wideband Analog-to-Digital Conversion.”
- Li, K., Saxena, V., and Baker, R. J., "The Baker ADC: An Overview,"
- Saxena, V., and Baker, R. J., "High-Speed Op-Amp Design: Compensation and Topologies for Two and Three Stage Designs,"
- Baker, R. J., "Circuit Design for MLC Flash: Towards a Semiconductor Replacement for the Hard Disk Drive."
- Baker, R. J., Terman Award Acceptance Speech, given at the Frontiers in Education Conference (FIE 2007), Milwaukee, WI, October 11, 2007.

- Baker, R. J., "The One-Transistor, One-Capacitor (1T1C) Dynamic Random Access Memory (DRAM), and its Impact on Society," presented at the Franklin Institute, in the symposium honoring Dr. Robert H. Dennard and his receipt of the 2007 Benjamin Franklin Medal in Electrical Engineering, April 25, 2007.
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EXPERT WITNESS EXPERIENCE

The law firms and clients (underlined) whom I have provided expert witness services in electrical and computer engineering are listed below. I have been deposed 71 times, given expert testimony at 10 trials (6 USITC, 2 D. Del., 1 S.D. Cal., and 1 E.D. Tex.), and participated in 1 mediation.

Paul Hastings, LLC (Washington, DC)

Case – Ex Parte Reexamination
Case Number – 90/014,846. Request filed on August 30, 2021.
Case Subject Matter – Wireless power transmission and ways to wirelessly charge and/or discharge a battery.
Work Performed – Provided expert consulting services and wrote declaration.

Jones Day (San Diego, CA and Pittsburgh, PA)

Case – *SOLiD, Inc.* v. CommScope Technologies LLC

Case Numbers – IPR2021-01390, IPR2021-01391, IPR2021-01392, IPR2021-01393, and IPR2021-01394. Petitions filed on August 12, 2021.

Case Subject Matter – Digital antenna system that enables extension of radio frequency (RF) analog signals from base stations to areas (e.g., inside of buildings) where access to such signals is inhibited.

Work Performed – Provided expert consulting services for inter partes reviews and wrote declaration.

Unified Patents, LLC (Washington, DC)

Case – Ex Parte Reexamination

Case Number – 90/019,015. Request filed on July 20, 2021.

Case Subject Matter – Voltage-controlled oscillator (VCO) temperature compensation.

Work Performed – Provided expert consulting services and wrote declaration.

Winston & Strawn LLP (Dallas, TX and Palo Alto, CA)

Case – *Micron Technology, Inc.; Micron Semiconductor Products, Inc.; Micron Technology Texas LLC* v. Unification Technologies LLC

Case Numbers – IPR2021-00940, IPR2021-00941, and IPR2021-00942. Petitions filed on June 4, 2024.

Case Subject Matter – Solid-State Drive (SSD), flash non-volatile memory management, memory controller operation and addressing.

Work Performed – Provided expert consulting services for inter partes reviews and wrote declarations.

O'Melveny & Myers LLP (San Francisco, CA)

Case – Super Interconnect Technologies LLC v. *Google LLC*

Case Number – Texas, ED (Marshall) 2:18-cv-00463 (complaint filed November 2, 2018) and Texas, WD (Waco) 6:21-cv-00259 (complaint filed March 15, 2021).

Case Subject Matter – Transmission of data and clock signals. Serial signals such as transition minimized differential signaling. Communications between processors and non-volatile storage such as Universal Flash Storage (UFS) and embedded MultiMedia Controller (eMMC).

Work Performed – Provided expert consulting services and wrote expert reports.

Orrick, Herrington & Sutcliffe LLP (Houston, TX, Irvine, CA, and Menlo Park, CA)

Case – *TCT Mobile Inc. and TCL Communication, Inc.* v. Fundamental Innovation Systems International LLC

Case Numbers – IPR2021-00597, IPR2021-00598, and IPR2021-00599. Petitions filed on February 26, 2021.

Case Number – IPR2021-00428. Petition filed on January 13, 2021.

Case Number – IPR2021-00410. Petition filed on January 11, 2021.

Case Number – IPR2021-00395. Petition filed on December 31, 2020.

Case Subject Matter – Universal Serial Bus (USB) for charging mobile devices.

Work Performed – Provided expert consulting services including writing declarations for inter partes reviews.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – *Samsung, Inc.* v. Pictos Technologies, Inc.

Case Number – IPR2021-00557. Petition filed on February 18, 2021.

Case Number – IPR2021-00436. Petition filed on January 19, 2021.

Case Numbers – IPR2021-00437 and IPR2021-00438. Petitions filed on January 15, 2021.

Case Subject Matter – Solid-state imaging devices including red, green, and blue pixels, data conversion circuits, and interpolation circuits. CMOS imagers including fabrication and design, active pixels, and semiconductor physics.

Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

O'Melveny & Myers LLP (San Francisco, CA) and DLA Piper (New York, NY)

Case – Solas OLED Ltd. v. *BOE Technology Group Co. Ltd. and Samsung Electronics*

Case Number – ITC Investigation No. 337-TA-1243. Complaint filed January 5, 2021.

Case Subject Matter – Active matrix OLED display devices and components

Work Performed – Provided expert consulting services including expert reports.

Paul Hastings LLP (Washington, DC)

Case – *Samsung, Inc.* v. Garrity Power Services LLC
Case Number – IPR2021-00389. Petition filed on December 31, 2020.
Case Subject Matter – Power electronics including full-bridge PWM modules for wireless power transmission using magnetic coupling via antennas and transformers. Design of inductors and coils.
Work Performed – Provided expert consulting services and wrote declaration for inter partes reviews.

Morgan, Lewis & Bockius LLP (Palo Alto, CA and Shanghai, CN)

Case – Monolithic Power Systems, Inc. v. *Meraki Integrated Circuit Technology, Inc. and Promate Electronic Company, LTD.*
Case Number – Texas, WD (Waco) 6:20-cv-00876. Complaint filed on December 24, 2020.
Case Subject Matter – Design of switching power supplies including synchronous rectification.
Work Performed – Provided expert consulting services including declaration for claim construction, trade secret analysis and declaration, and Markman tutorial.

Winston & Strawn LLP (Dallas, TX and Palo Alto, CA)

Case – *Micron Technology, Inc.; Micron Semiconductor Products, Inc.; Micron Technology Texas LLC; Dell Technologies Inc.; Dell Inc.; and HP Inc.* v. Unification Technologies LLC
Case Numbers – IPR2021-00343, IPR2021-00344, and IPR2021-00345. Petitions filed on December 22, 2020.
Case Subject Matter – Solid-State Drive (SSD), flash non-volatile memory management, memory controller operation and addressing.
Work Performed – Provided expert consulting services for inter partes reviews and wrote declarations.

O'Melveny & Myers LLP (Los Angeles, CA)

Case – Cosemi Technologies, Inc. v. EverPro Technologies, Fibbr Technologies, *Logitech, Inc.*, and Facebook Technologies
Case Number – ITC Investigation No. 337-TA-1233. Complaint filed October 28, 2020.
Case Subject Matter – Data cables, including HDMI, Display Port, and USB Type A, USB Type C and USB Type A/C data cables.
Work Performed – Provided expert consulting services.

Kirkland & Ellis LLP (Boston, MA and New York, NY)

Case – Pictos Technologies, Inc. v. *Samsung Electronics Co., LTD. and Samsung Semiconductor, Inc.*
Case Number – ITC Investigation No. 337-TA-1231. Complaint filed September 25, 2020.
Case Subject Matter – Solid-state imaging devices including red, green, and blue pixels, correction of bad pixels, data conversion circuits, and interpolation circuits. CMOS imagers including fabrication and design, active pixels, and semiconductor physics.
Work Performed – Provided expert consulting services and wrote expert report.

Orrick, Herrington & Sutcliffe LLP (Houston, TX, Irvine, CA, and Menlo Park, CA)

Case – Fundamental Innovation Systems International LLC v. *TCT Mobile Inc. and TCL Communication, Inc.*
Case Number – Delaware, 1:20-cv-00552. Complaint filed on September 11, 2020.
Case Subject Matter – Universal Serial Bus (USB) for charging mobile devices.
Work Performed – Provided expert consulting services including writing declarations.

Walters Wilson LLP (Redwood City, CA)

Case – *Western Digital Corporation and SanDisk, LLC* v. Martin Kuster
Case Numbers – IPR2020-01410 and IPR2020-01411. Petitions filed on August 3, 2020.
Case Subject Matter – Computer connectors such as universal serial bus (USB) that connect to peripheral devices such as mice, keyboards, displays, printers, external storage, etc.
Work Performed – Provided expert consulting services for inter partes review, wrote declarations and was deposed.

O'Melveny & Myers LLP (Los Angeles, CA)

Case – *Advanced Micro Devices, Inc.* v. Monterey Research, LLC
Case Number – IPR2020-01315. Petition filed on July 16, 2020.
Case Number – IPR2020-00985. Petition filed on May 26, 2020.
Case Subject Matter – Reading and writing to semiconductor memory such as SRAM and DRAM. Buffer circuits with variable current supplies for controlling the rise and fall times of output signals.
Work Performed – Provided expert consulting services for inter partes review, wrote declarations and was deposed twice.

Winston & Strawn LLP (Dallas, TX and Palo Alto, CA)

Case – Unification Technologies LLC v. *Micron Technology, Inc.; Micron Semiconductor Products, Inc.; Micron Technology Texas LLC*
Case Number – Texas, WD (Waco) 6:20-cv-00500. Complaint filed June 5, 2020.
Case Subject Matter – Solid-State Drive (SSD), flash non-volatile memory management, memory controller operation and addressing.
Work Performed – Provided expert consulting services, wrote declaration for claim construction, and was deposed.

Ari Law, P.C. (Palo Alto, CA) and Hill, Kertscher & Wharton, LLP (Atlanta, GA)

Case – *Sanho Corporation* v. Kaijet Technology, Magic Control Technology, and Starview Global
Case Numbers – Georgia, ND (Atlanta) 1:18-cv-05385 (third amended complaint filed November 14, 2019) and Georgia, ND (Atlanta) 1:20-cv-02150 (filed May 19, 2020).
Case Subject Matter – Port extension apparatus for headphone jack, USB (Universal Serial Bus or Type-C ports), and video ports such as VGA (Video Graphics Array), DVI (Digital Visual Interface), HDMI (High-Definition Multimedia Interface), DP (Display Port), and mini-DP.
Work Performed – Provided expert consulting services and wrote declaration for claim construction.

Orrick, Herrington & Sutcliffe LLP (Houston, TX, Irvine, CA, and Menlo Park, CA)

Case – Fundamental Innovation Systems International LLC v. *Coolpad Group Limited, Coolpad Technologies, Inc., and Yulong Computer Telecommunication Scientific Co. Ltd.*
Case Number – Texas, ED (Marshall) 2:20-cv-00117. Complaint filed on April 23, 2020.
Case Subject Matter – Universal Serial Bus (USB) for charging mobile devices.
Work Performed – Provided expert consulting services including writing declaration for claim construction.

Pillsbury Winthrop Shaw Pittman LLP (San Francisco, CA and Shanghai, China)

Case – *SMIC, Americas* v. Innovative Foundry Technologies LLC
Case Numbers – IPR2020-00837 and IPR2020-00839. Petitions filed on April 14, 2020.
Case Subject Matter – Methods of manufacturing a semiconductor component, such as a short-channel MOS device, including forming graded-junctions using spacers along the sidewalls of a transistor's gate.
Work Performed – Provided expert consulting services for inter partes reviews and wrote declarations.

Russ August & Kabat (Los Angeles, CA)

Case – Seoul Semiconductor Co., Ltd. v. *Document Security Systems, Inc.*
Case Number – IPR2020-00938. Petition filed on May 18, 2020.
Case – Nichia Corporation v. *Document Security Systems, Inc.*
Case Number – IPR2020-00908. Petition filed on May 18, 2020.
Case – Cree, Inc. v. *Document Security Systems, Inc.*
Case Number – IPR2020-00557. Petition filed on February 11, 2020.
Case Subject Matter – Light emitting diodes (LEDs) as a light source, extraction of light.
Work Performed – Provided expert consulting services, wrote declaration for inter partes reviews, and was deposed three times.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – *Flex Logix Technologies, Inc.* v. Konda Technologies Inc.

Case Numbers – IPR2020-00260, IPR2020-00261, and IPR2020-00260. Petitions filed on December 16, 2019.

Case Numbers – PGR2019-00037, PGR2019-00040, and PGR2019-00042. Petitions filed on March 18, 2019.

Case Subject Matter – FPGA layout routing for integrated circuits and networks, electrical and computer engineering.

Work Performed – Provided expert consulting services and wrote declarations for post grant and inter partes reviews.

DLA Piper (Chicago, IL, Houston, TX, and Washington, DC) and White & Case LLP (New York, NY and Washington, DC)

Case – M-Red Inc. v. *Panasonic Corporation*

Case Number – Texas, ED (Marshall) 2:19-cv-00251. Complaint filed on July 16, 2019.

Case Subject Matter – Integrated circuit electronics adjustment, such as ring oscillators, using auto calibration. Evaluating a known good die using both wire and flip-chip interconnects.

Work Performed – Provided expert consulting services and wrote declaration for claim construction.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – *Samsung, Inc.* v. NuCurrent, Inc.

Case Number – IPR2019-01217. Petition filed on June 19, 2019.

Case Numbers – PGR2019-00049 and PGR2019-00050. Petitions filed on May 28, 2019.

Case Numbers – IPR2019-00858, IPR2019-00859, IPR2019-00860, IPR2019-00861, IPR2019-00862, and IPR2019-00863. Petitions filed on March 22, 2019.

Case Subject Matter – Wireless power transmission using magnetic coupling via antennas and transformers. Design of inductors and coils.

Work Performed – Provided expert consulting services and wrote declarations for post grant and inter partes reviews. Was deposed five times.

DLA Piper (East Palo Alto, CA)

Case – Invensas Corporation and Tessera Advanced Technologies, Inc. v. *NVIDIA Corporation*

Case Number – Delaware, 1:19-cv-00861. Complaint filed on May 8, 2019.

Case Subject Matter – Reference voltage circuits (programmable bandgaps) having a substantially zero temperature coefficient using bipolar and MOS transistors.

Work Performed – Provided expert consulting services.

Irell & Manella LLP (Los Angeles, CA)

Case – *VLSI Technology LLC* v. Intel Corporation

Case Number – Texas, WD (Waco) 6:19-cv-00256. Complaint filed on April 11, 2019.

Case Subject Matter – Static Random Access Memory (SRAM) having a variable power supply using charge-sharing capacitors, methods for designing digital systems, and hardware managed interrupt control.

Work Performed – Provided expert consulting services, wrote expert reports, declaration, and was deposed.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – *Samsung, Inc.* v. ProMOS Technologies, Inc.

Case Numbers – IPR2019-00779, IPR2019-00780, IPR2019-00781, IPR2019-00784, and IPR2019-00785. Petitions filed on March 5, 2019.

Case Subject Matter – Programmable latches that include non-volatile programmable elements, digital delay elements, and decoders for memory chips.

Work Performed – Provided expert consulting services, wrote declarations for inter partes reviews, and was deposed four times.

Pillsbury Winthrop Shaw Pittman LLP (San Francisco, CA)

Case – *Kingston Technology Company, Inc.* v. Memory Technologies, LLC

Case Numbers – IPR2019-00645, IPR2019-00648, IPR2019-00651, and IPR2019-00654. Petitions filed on January 31, 2019.

Case Numbers – IPR2019-00642, IPR2019-00643, and IPR2019-00644. Petitions filed on January 30, 2019.

Case Number – IPR2019-00638. Petition filed on January 29, 2019.

Case Subject Matter – Memory cards including PC cards, compact flash ("CF") cards, secure digital ("SD") cards, programmable credit cards, and embedded multimedia cards ("eMMC"). Uses of EEPROM and Flash memory in built-in operating system (BIOS).

Work Performed – Provided expert consulting services for inter partes reviews and wrote declarations.

Russ August & Kabat (Los Angeles, CA)

Case – Ring LLC v. *SkyBell Technologies, Inc.*

Case Numbers – IPR2019-00443, IPR2019-00444, IPR2019-00445, IPR2019-00446, and IPR2019-00447. Petitions filed on December 17, 2018.

Case Subject Matter – Electronic doorbell system with digital chime, video, motion detection, wired and wireless communication, and control panel.

Work Performed – Provided expert consulting services, wrote declarations for inter partes reviews, and was deposed three times.

Baker Botts LLP (Austin, TX)

Case – *Semiconductor Components Industries, LLC a/b/a ON Semiconductor* v. Power Integrations, Inc.

Case Numbers – IPR2018-01810, IPR2018-01812, IPR2018-01816, and IPR2018-01818. Petitions filed on September 28, 2018.

Case Subject Matter – Switched-mode power supplies (e.g., flyback, buck, boost), controllers, transformers, and sensing multiple voltage values.

Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

Kirkland & Ellis LLP (Washington, DC) and Fish & Richardson P.C. (Washington, DC)

Case – *Samsung Electronics Co., LTD. and SK hynix Inc.* v. BiTMICRO, LLC

Case Number – IPR2018-01720. Petition filed on September 19, 2018.

Case Number – IPR2018-01545. Petition filed on August 23, 2018.

Case Subject Matter – Solid state storage drives, stacked consumer electronics components (3D packaging, solder balls, flip-chip, TSVs, etc.), and products.

Work Performed – Provided expert consulting services including writing declarations for inter partes reviews.

Knobbe, Martens, Olson, & Bear, LLP (Los Angeles, CA) and White & Case LLP (Palo Alto, CA and Washington, DC)

Case – *Toshiba America Information Systems, Inc. and MSI Computer Corp.* v. Walletex Microelectronics Ltd.

Case Number – IPR2018-01538. Petition filed on August 10, 2018.

Case Subject Matter – Double-sided male USB and various card-shaped devices and connectors, electrical and computer engineering.

Work Performed – Provided expert consulting services including writing declarations for inter partes review and was deposed.

Jones Day (Cleveland, OH and Pittsburgh, PA)

Case – Intel Corp. v. *Qualcomm, Inc.*

Case Numbers – IPR2018-01344 and IPR2018-01346. Petitions filed on July 6, 2018.

Case Numbers – IPR2018-01261, IPR2018-01293, and IPR2018-01295. Petitions filed on June 29, 2018.

Case Subject Matter – Communications, e.g., PCI Express (PCIe), USB, Firewire (IEEE-1394), between two processing nodes within a computing device such as a cell phone, tablet, or computer.

Work Performed – Provided expert consulting services for inter partes reviews including writing declaration and was deposed.

Orrick, Herrington & Sutcliffe LLP (Menlo Park, CA) and Weil, Gotshal & Manges LLP (Redwood Shores, CA)
Case – *Micron Technology, Inc.* v. North Star Innovations, Inc.
Case Numbers – IPR2018-00998 and IPR2018-00999. Petitions filed on May 1, 2018.
Case Number – IPR2018-00989. Petition filed on April 27, 2018.
Case Subject Matter – Output circuits for memory integrated circuits and voltage boosting circuits.
Work Performed – Provided expert consulting services including writing declarations for inter partes reviews, and was deposed.

Paul Hastings LLP (Austin, TX and Washington, DC)
Case – *Samsung, Inc.* v. Red Rock Analytics, LLC
Case Numbers – IPR2018-00555, IPR2018-00556, and IPR2018-00557. Petitions filed on February 5, 2018.
Case Subject Matter – Calibration of IQ balance in transceivers in wireless communications (OFDM, 802.11, Bluetooth, 3G, 4G, etc.).
Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

Covington & Burling LLP (Palo Alto, CA and Washington, DC)
Case – Phenix (sic) Longhorn, LLC v. *Texas Instruments, Inc.*
Case Number - Texas, ED (Marshall) 2:18-cv-00020. Complaint filed January 22, 2018.
Case Subject Matter – Circuit with non-volatile memory for gamma correction in a display screen.
Work Performed – Provided expert consulting services, wrote declaration for claim construction, expert reports, and was deposed twice.

Kirkland & Ellis LLP (Washington, DC) and Fish & Richardson P.C. (Washington, DC)
Case – BiTMICRO, LLC v. *Samsung Electronics Co., LTD.*, *SK hynix Inc.*, *Dell Inc.*, *Lenovo Group Inc.*, *HP Inc.*, *ASUSTek Computer Inc.*, *ASUS Computer International*, *ACER Inc.*, *VAIO Corporation*, and *Transcosmos America Inc.*
Case Number – ITC Investigation No. 337-TA-1097. Complaint filed January 8, 2018.
Case Subject Matter – Solid state storage drives (SSDs), stacked electronics components (3D packaging, solder balls, flip-chip, TSVs, etc.), and products.
Work Performed – Provided expert consulting services including direct witness statement, deposition, and testified at trial for pilot 100-day ITC proceeding.

Morrison & Foerster LLP (Los Angeles, CA)
Case – SK hynix, Inc. v. *Netlist, Inc.*
Case Numbers – IPR2018-00364 and IPR2018-00365. Petitions filed on December 27, 2017.
Case Numbers – IPR2018-00362 and IPR2018-00363. Petitions filed on December 22, 2017.
Case Subject Matter – Memory modules, components, and products.
Work Performed – Provided expert consulting services for patent owner in inter partes reviews, wrote declarations, and was deposed twice.

Quinn Emanuel Urquhart & Sullivan, LLP (San Francisco, CA and Chicago, IL) and Norton Rose Fulbright US LLP (Houston, TX)
Case – *Qualcomm, Inc.* v. Apple, Inc.
Case Number – ITC Investigation No. 337-TA-1093. Complaint filed November 30, 2017.
Case Subject Matter – Certain mobile electronic devices and radio frequency integrated circuits and processing components thereof. Communications, e.g., PCI Express (PCIe), USB, Firewire (IEEE-1394), between two processing nodes.
Work Performed – Provided expert consulting services.

Baker Botts LLP (Austin, TX, and Houston, TX)
Case – *Semiconductor Components Industries, LLC a/b/a ON Semiconductor* v. Power Integrations, Inc.
Case Number – IPR2018-00160. Petition filed on November 7, 2017.
Case Subject Matter – Switched-mode power supplies and power supply controllers.
Work Performed – Provided expert consulting services and wrote declaration for inter partes review.

Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C. (Boston, MA)
Case – *Netlist, Inc.* v. SK hynix, Inc.
Case Number – ITC Investigation No. 337-TA-1089. Complaint filed on October 31, 2017.
Case Subject Matter – Memory modules and components thereof.
Work Performed – Provided expert consulting services including validity analysis, expert report, deposition, and testified at trial.

Baker Botts LLP (Austin, TX, and Houston, TX)
Case – *ON Semiconductor and Semiconductor Components Industries* v. Power Integrations, Inc.
Case Number – Delaware, 1:17-cv-00247. First amended complaint filed on September 8, 2017.
Case Subject Matter – Switched-mode power supplies and power supply controllers.
Work Performed – Provided expert consulting services.

Quinn Emanuel Urquhart & Sullivan, LLP (San Francisco, CA, Chicago, IL and Seattle, WA)
Case – *Qualcomm, Inc.* v. Apple, Inc.
Case Number – California, SD 3:17-cv-01375. Complaint filed on August 25, 2017.
Case Subject Matter – Electronics in consumer mobile devices. Communications, e.g., PCI Express (PCIe), USB, Firewire (IEEE-1394), between two processing nodes.
Work Performed – Provided expert consulting services including infringement analysis, validity analysis, expert reports, was twice deposed, and testified at trial.

Baker Botts LLP (Austin, TX, and Houston, TX)
Case – Power Integrations v. *ON Semiconductor and Semiconductor Components Industries*
Case – *ON Semiconductor and Semiconductor Components Industries* v. Power Integrations, Inc.
Case Numbers – California, ND (San Jose) 5:16-cv-06371 and California ND (San Jose) 5:17-cv-03189. Second amended complaint filed on August 14, 2017.
Case Subject Matter – Switched-mode power supplies and power supply controllers (power electronics).
Work Performed – Provided expert consulting services and wrote declaration for claim construction.

Fish & Richardson P.C. (Washington, DC)
Case – Ex Parte Reexamination
Case Number – 90/020,112. Request filed on July 31, 2017.
Case Subject Matter – Multi-level non-volatile floating gate memory (MLC), e.g. EPROM, EEPROM, and flash technologies.
Work Performed – Provided expert consulting services and wrote declaration.

K&L Gates LLP (Chicago, IL)
Case – *United Microelectronics Corp.*, *UMC Group (USA)*, *Semiconductor Manufacturing International Corp. (Shanghai and Beijing)*, and *SMIC (Americas)*, v. Lone Star Silicon Innovations LLC
Case Number – IPR2017-01513. Petition filed on July 20, 2017.
Case Subject Matter – CMOS circuit fabrication.
Work Performed – Provided expert consulting services and wrote declaration for inter partes review.

Bosch Jehle and Fieldfisher (Munich and Düsseldorf, Germany)
Case – *Netlist, Inc.* v. SK hynix, Inc.
Case Number – Complaint filed on July 11, 2017 in the German Federal Patent Court.
Case Subject Matter – Memory modules and components and products containing same.
Work Performed – Provided expert consulting services and attended trial at the German Federal Patent Court in Munich.

Quinn Emanuel Urquhart & Sullivan, LLP (San Francisco, CA, Chicago, IL, and Seattle, WA)

Case – *Qualcomm, Inc.* v. Apple, Inc.
Case Number – ITC Investigation No. 337-TA-1065. Complaint filed July 7, 2017.
Case Subject Matter – Certain mobile electronic devices and radio frequency and processing components thereof.
Work Performed – Provided expert consulting services including infringement analysis, validity analysis, expert reports, was deposed, and testified at trial.

Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C. (Boston, MA and Washington, DC)

Case – *Netlist, Inc.* v. SK hynix
Case Number – California, CD 8:17-cv-01030. Complaint filed on June 14, 2017.
Case Subject Matter – Memory modules and components and products containing same.
Work Performed – Provided expert consulting services.

Russ August & Kabat (Los Angeles, CA)

Case – *Document Security Systems, Inc.* v. Lite-On, Inc.
Case Number – California, CD 2:17-cv-06050. Complaint filed on August 15, 2017.
Case – *Document Security Systems, Inc.* v. Everlight Electronics Co.
Case Number – California, CD 2:17-cv-04273. Complaint filed on June 8, 2017.
Case – *Document Security Systems, Inc.* v. Cree, Inc.
Case Number – California, CD 2:17-cv-04263. Complaint filed on June 8, 2017.
Case – *Document Security Systems, Inc.* v. Seoul Semiconductor Company, LTD.
Case Number – California, CD 8:17-cv-00981. Complaint filed on June 7, 2017.
Case Subject Matter – Light Emitting Diode ("LED") lighting products.
Work Performed – Provided expert consulting services, wrote claim construction declarations and was deposed.

Dovel & Luner LLP (Santa Monica, CA)

Case – *X2Y Attenuators, LLC* v. Intel Corporation
Case Number – Oregon, D (Portland) 3:18-cv-01394 (moved from Pennsylvania, WD [Erie]). Complaint filed June 22, 2017.
Case Subject Matter – Circuit arrangements that use relative groupings of energy pathways in capacitive filters for filtering noise on printed circuit boards (PCBs), electrical engineering.
Work Performed – Provided expert consulting services.

Kirkland & Ellis LLP (New York, NY and Washington, DC)

Case – Fundamental Innovation Systems International LLC v. *Samsung Electronics Co., LTD.*
Case Number – Texas, ED (Marshall) 2:17-cv-00145. Complaint filed May 15, 2017.
Case Subject Matter – Universal Serial Bus (USB) connections for data communications and charging.
Work Performed – Provided expert consulting services, wrote expert reports on invalidity and noninfringement, and was deposed.

Paul Hastings LLP (Austin, TX and Washington, DC)

Case – *Samsung, Inc.* v. ProMOS Technologies, Inc.
Case Numbers – IPR2017-01412, IPR2017-01413, IPR2017-01414, IPR2017-01415, and IPR2017-01416. Petitions filed on May 12, 2017.
Case Subject Matter – Delay-Locked Loop (DLL) design, power supplies, and sensing in semiconductor memory.
Work Performed – Provided expert consulting services, wrote declarations for inter partes reviews, and was deposed three times.

Baker Botts LLP (Austin, TX, Dallas, TX, and Palo Alto, CA)

Case – *SanDisk LLC* v. Memory Technologies, LLC
Case Number – IPR2017-01420. Petition filed on May 10, 2017.
Case Number – IPR2017-01360. Petition filed on May 3, 2017.
Case Number – IPR2017-01116. Petition filed on March 20, 2017.
Case Number – IPR2017-01022. Petition filed on March 3, 2017.
Case Number – IPR2017-00868. Petition filed on February 9, 2017.
Case Subject Matter – Memory cards including PC cards, compact flash ("CF") cards, secure digital ("SD") cards, programmable credit cards, and multimedia cards ("MMC"). Uses of EEPROM and Flash memory in built-in operating system (BIOS).
Work Performed – Provided expert consulting services for inter partes review and wrote declarations.

DLA Piper (Atlanta, GA and East Palo Alto, CA)

Case – Macronix International Co. v. *Toshiba, Inc.*
Case Number – ITC Investigation No. 337-TA-1046. Complaint filed March 7, 2017.
Case Subject Matter – Non-volatile memory, such as flash and resistive (phase-change memory [PCM] using chalcogenide materials and programmable contacts in cross-point arrays) memory, and products containing the same.
Work Performed – Provided expert consulting services. Also provided Markman tutorial, expert reports, was deposed, and testified at trial.

Morrison & Foerster LLP (Los Angeles, CA)

Case – SK hynix, Inc. v. *Netlist, Inc.*
Case Number – IPR2017-00577. Petition filed on January 5, 2017.
Case Subject Matter – Memory modules, components, and products.
Work Performed – Provided expert consulting services for patent owner in an inter partes review, wrote declaration, and was deposed.

McAndrews Held & Malloy LTD (Chicago, IL)

Case – SK hynix, Inc. v. *Netlist, Inc.*
Case Number – IPR2017-00692. Petition filed on January 17, 2017.
Case Number – IPR2017-00587. Petition filed on January 6, 2017.
Case Number – IPR2017-00561. Petition filed on January 5, 2017.
Case Numbers – IPR2017-00560 and IPR2017-00562. Petitions filed on January 3, 2017.
Case Subject Matter – Volatile and non-volatile memory systems.
Work Performed – Provided expert consulting services for patent owner in an inter partes review, wrote declarations, and was deposed twice.

O'Melveny & Myers LLP (Newport Beach and Los Angeles, CA)

Case – Janus Semiconductor, LLC v. *Micron Technology, Inc.*
Case Number – Texas, ED (Marshall) 2:16-cv-01409. Complaint filed December 13, 2016.
Case Subject Matter – Self-timed and self-enabled distributed clocking in electronic integrated circuits.
Work Performed – Provided expert consulting services.

Baker Botts LLP (Austin, TX, Dallas, TX, and Palo Alto, CA)

Case – Memory Technologies, LLC v. *SanDisk LLC* and *Western Digital Corporation*
Case Number – ITC Investigation No. 337-TA-1034. Complaint filed November 30, 2016.
Case Subject Matter – SD Cards, microSD cards, programmable credit cards, eMMC (embedded Multi-Media Controller), and eMCP (embedded Multi-Chip Packages) products.
Work Performed – Provided expert consulting services and wrote declaration.

Kilpatrick Townsend & Stockton LLP (Denver, CO and Shanghai, China)
Case – *Broadcom, Ltd.* v. Invensas
Case Number – IPR2017-00171. Petition filed on October 31, 2016.
Case Subject Matter – Semiconductor random access memory circuit timing and operation.
Work Performed – Provided expert consulting services, wrote declaration, and was deposed.

Paul Hastings LLP (Washington, DC)
Case – *Samsung, Inc.* v. ProMOS Technologies, Inc.
Case Numbers – IPR2017-00036, IPR2017-00038, and IPR2017-00039. Petitions filed on October 7, 2016.
Case Subject Matter – Sensing in semiconductor memory integrated circuits.
Work Performed – Provided expert consulting services, wrote declarations for inter partes reviews, and was deposed three times.

Munck Wilson Mandala LLP (Dallas, TX)
Case – *ams AG*, *ams-TAOS*, and *Samsung* v. JJL Technologies and 511 Innovations, Inc.
Case Numbers – IPR2016-01788, IPR2016-01792, IPR2016-01793, IPR2016-01804, IPR2016-01810, IPR2016-01818, and IPR2016-01819. Petitions filed on September 14, 2016.
Case Number – IPR2016-01787. Petition filed on September 13, 2016.
Case Subject Matter – Color and optical measuring systems.
Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C. (Boston, MA and Washington, DC)
Case – *Netlist, Inc.* v. SK hynix, Inc.
Case Number – ITC Investigation No. 337-TA-1023. Complaint filed on September 1, 2016.
Case Subject Matter – Memory modules and components and products containing same.
Work Performed – Provided expert consulting services including validity analysis, expert report, deposition, technology tutorial at trial, and trial testimony.

Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C. (Boston, MA and Washington, DC)
Case – *Netlist, Inc.* v. SK hynix
Case Number – California, CD (Santa Ana) 8:16-cv-01605. Complaint filed on August 31, 2016.
Case Subject Matter – Memory modules and components and products containing same.
Work Performed – Provided expert consulting services and wrote declaration for claim construction.

Baker & Hostetler LLP (Cleveland, OH)
Case – *Evolv, LLC* v. Joyetech and Wismec
Case Number – California, CD 8:16-cv-00459.
Complaint filed on March 9, 2016. Case Subject Matter – Electronic personal vaporizers (also known as electronic cigarettes) containing power and USB battery charging electronics and switching power supplies using CMOS and power MOSFETs.
Work Performed – Provided expert consulting services including lab testing and infringement analysis. Wrote declaration.

Vinson & Elkins LLP (San Francisco, CA)
Case – Polaris Innovations Limited v. Kingston Technology Company, Inc.
Case Number – California, CD 8:16-cv-300. Complaint filed on February 19, 2016.
Case Subject Matter – Semiconductor memory, circuits, and the design and fabrication of memory modules.
Work Performed – Provided expert consulting services.

Mintz, Levin, Cohn, Ferris, Glovsky and Popeo, P.C. (Boston, MA)
Case – *Advanced Silicon Technologies LLC* v. BMW, Fujitsu, Harman, Honda, NVIDIA, Renesas, Texas Instruments, Toyota, Volkswagen, and Audi
Case Number – ITC Investigation No. 337-TA-984. Complaint filed on December 28, 2015.
Case Subject Matter – Computing or graphics systems, components thereof, and vehicles containing same.
Work Performed – Provided expert consulting services and wrote declaration for claim construction.

DLA Piper (East Palo Alto, CA, Chicago, IL, and Reston, VA)
Case – Lincoln Electric v. *ESAB, Inc.*
Case Number – Texas, ED (Marshall) 2:15-cv-01404. Complaint filed on December 15, 2015.
Case Subject Matter – Power electronics including switching power supplies using power MOSFETs for welding equipment.
Work Performed – Provided expert consulting, claim construction, noninfringement analysis, invalidity analysis, expert reports, and was deposed twice.

Weil, Gotshal & Manges LLP (Houston, TX and Redwood Shores, CA)
Case – *Micron Technology, Inc.* v. Innovative Memory Systems LLC
Case Numbers – IPR2016-00320, IPR2016-00322, IPR2016-00325, IPR2016-00326, and IPR2016-00327. Petitions filed on December 14, 2015.
Case Subject Matter – Data conversion, semiconductor fabrication, flash memory, and semiconductor memory device operation/control.
Work Performed – Provided expert consulting services, wrote declarations for inter partes reviews, and was deposed three times.

Munck Wilson Mandala LLP (Dallas, TX) and O'Melveny & Myers LLP (Los Angeles, CA)
Case – 511 Innovations, Inc. v. *Samsung*, *Huawei*, *ZTE*, and *ams-TAOS*
Case Number – Texas, ED (Marshall) 2:15-cv-01526. Complaint filed on September 14, 2015.
Case Subject Matter – Color and optical measuring systems.
Work Performed – Provided expert consulting, claim construction, wrote declaration, expert reports, and was deposed twice.

Davis Wright Tremaine LLP (San Francisco, CA and Seattle, WA) and Mayer Brown LLP (Washington, DC)
Case – 511 Innovations, Inc. v. *Microsoft and Avago*
Case Number – Texas, ED (Marshall) 2:15-cv-01525. Complaint filed on September 14, 2015.
Case Subject Matter – Color and optical measuring systems.
Work Performed – Provided expert consulting services.

Weil, Gotshal & Manges LLP (Houston, TX, Redwood Shores, CA, and Washington, DC)
Case – *Micron Technology, Inc.* v. Limestone Memory Systems LLC
Case Numbers – IPR2016-00093, IPR2016-00094, IPR2016-00095, IPR2016-00096, and IPR2016-00097. Petitions filed on October 27, 2015.
Case Subject Matter – Semiconductor memory.
Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

DLA Piper (East Palo Alto and Los Angeles, CA)
Case – *Apple, Inc.* v. Longitude Flash Memory Systems S.A.R.L.
Case Number – IPR2015-01933. Petition filed on September 21, 2015.
Case Numbers – IPR2015-01924 and IPR2015-01925. Petitions filed on September 17, 2015.
Case Numbers – IPR2015-01908 and IPR2015-01909. Petitions filed on September 14, 2015.
Case Subject Matter – Non-volatile semiconductor flash memory fabrication and design.
Work Performed – Provided expert consulting services and wrote declarations for inter partes reviews.

Paul Hastings LLP (New York City, NY and Washington, DC)
Case – *Samsung, Inc.* v. Elbrus International Limited
Case Numbers – IPR2015-01523 and IPR2015-01524. Petitions filed on June 26, 2015.
Case Subject Matter – High-speed, low-power data transfer.
Work Performed – Provided expert consulting services, wrote declarations for inter partes reviews, and was deposed.

Kilpatrick Townsend & Stockton LLP (Menlo Park and San Francisco, CA)

Case – Consultant for *SK hynix*, Inc. on matters relating to investigation of certain patents owned by Longitude Licensing Ltd.
Case Subject Matter – Semiconductor random access memory and communication interfaces.
Work Performed – Provided expert consulting services in 2015.

Ropes & Gray LLP (New York City, NY)

Case – *Samsung, Inc.* v. Imperium IP Holdings (Cayman), Ltd.
Case Number – IPR2015-01233. Petition filed on May 21, 2015.
Case Subject Matter – Data interface circuits, such as I/O buffers, that can be either a single-ended interface or a differential interface.
Work Performed – Provided expert consulting services, wrote declarations for inter partes review, and was twice deposed.

Morgan, Lewis & Bockius LLP (Palo Alto, CA)

Case – *Silergy Corporation* v. Monolithic Power Systems, Inc.
Case Numbers – IPR2015-00803 and IPR2015-00804. Petitions filed on February 24, 2015.
Case Subject Matter – Microelectronic packaging.
Work Performed – Provided expert consulting services, wrote declarations for inter partes reviews, and was deposed.

Weil, Gotshal & Manges LLP (Houston, TX, Redwood Shores, CA, and Washington, DC)

Case – Limestone Memory Systems LLC v. *Micron Technology, Inc.*
Case Number – California, CD 8:15-cv-00278. Complaint filed on February 17, 2015.
Case Subject Matter – Semiconductor memory.
Work Performed – Provided expert consulting, claim construction, noninfringement analysis, and invalidity analysis.

Jones Day (San Diego, CA)

Case – *Micron Technology, Inc.* v. eDigital Corp.
Case Number – IPR2015-00519. Petition filed on December 31, 2014.
Case Subject Matter – Methods for memory management in non-volatile flash memories.
Work Performed – Provided expert consulting services and wrote declaration for inter partes review.

Fish & Richardson P.C. (Atlanta, GA and Washington, DC)

Case – *Micron Technology, Inc.* v. MLC Intellectual Properties and BTG USA/International Inc.
Case Number – IPR2015-00504. Petition filed on December 24, 2014.
Case Subject Matter – Multi-level non-volatile floating gate memory, e.g. EPROM, EEPROM, and flash technologies.
Work Performed – Provided expert consulting services and wrote declaration for inter partes review.

Weil, Gotshal & Manges LLP (Houston, TX and Redwood Shores, CA)

Case – Innovative Memory Systems LLC v. *Micron Technology, Inc.*
Case Number – Delaware, 1:14-cv-01480. Complaint filed on December 15, 2014.
Case Subject Matter – Data conversion, semiconductor fabrication, flash memory, and semiconductor memory device operation/control.
Work Performed – Provided expert consulting, claim construction, noninfringement analysis, and invalidity analysis.

Skadden, Arps, Slate, Meagher & Flom LLP & Affiliates (Palo Alto, CA)

Case – ALFRED T. GIULIANO, Chapter 7 Trustee of the Ritz Estate; CPM ELECTRONICS INC.; E.S.E. ELECTRONICS, INC. and MFLASH, INC., on Behalf of Themselves and All Others Similarly Situated v. *SanDisk Corp.*
Case Number – California, ND (Oakland) 4:10-cv-02787. Fourth amended complaint filed on September 24, 2014.
Case Subject Matter – Non-volatile semiconductor flash memory fabrication and design.
Work Performed – Provided expert consulting services.

DLA Piper (East Palo Alto and Los Angeles, CA)

Case – Longitude Licensing Ltd. and Longitude Flash Memory Systems S.A.R.L., v. *Apple, Inc.*
Case Number – California, ND 3:14-cv-04275. Complaint filed on September 23, 2014.
Case Subject Matter – Non-volatile semiconductor flash memory fabrication and design.
Work Performed – Provided expert consulting, claim construction, noninfringement analysis, and invalidity analysis.

Singularity LLP (Redwood Shores, CA)

Case – VIA Technologies, Inc. v. *ASUS Computer International*, *AUSTEK Computer*, *and ASMedia Technology, Inc.*
Case Number – California, ND (San Jose) 5:14-cv-03586. Complaint filed on August 7, 2014.
Case Subject Matter – USB 3.0 circuits.
Work Performed – Provided expert consulting services including: noninfringement, invalidity, and trade secret analyses. Wrote expert reports, was deposed twice, and participated in mediation.

Paul Hastings LLP (New York City, NY and Washington, DC)

Case – Cascades Computer Innovation, LLC v. *Samsung Electronics Co., Ltd.*
Case Number - Illinois, ED 14-cv-05691. Complaint filed on July 24, 2014.
Case Subject Matter – DRAM memory data transfer.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

Morgan, Lewis & Bockius LLP (Palo Alto, CA)

Case – Monolithic Power Systems, Inc. v. *Silergy Corporation*
Case Number – California, ND 3:14-cv-01745. First amended complaint filed on July 7, 2014.
Case Subject Matter – Microelectronic packaging.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

Ropes & Gray LLP (East Palo Alto, CA, New York City, NY, and Washington, DC)

Case – Macronix International Co., Ltd. v. *Spansion, Inc.*, *Aerohive Networks*, *Allied Telesis*, *Ciena*, *Delphi Automotive*, *Polycom*, *Ruckus Wireless*, *ShoreTel*, *Tellabs*, and *TiVo*
Case Number – ITC Investigation No. 337-TA-922. Complaint filed on June 27, 2014.
Case Subject Matter – Devices containing non-volatile memory and products containing the same.
Work Performed – Provided expert consulting, noninfringement analysis, invalidity analysis, Markman tutorial, and expert report.

Ropes & Gray LLP (Boston, MA and New York City, NY)

Case – Imperium IP Holdings (Cayman), Ltd. v. *Samsung, Inc.*
Case Number – Texas, ED (Sherman) 4:14-cv-00371. Complaint filed on June 9, 2014.
Case Subject Matter – Data interface circuits that can be either a single-ended interface or a differential interface.
Work Performed – Provided expert consulting, noninfringement analysis, invalidity analysis, expert reports, deposition, and testimony at the trial.

Quinn Emanuel Urquhart & Sullivan, LLP (San Francisco, CA and Washington, DC)

Case – Freescale Semiconductor, Inc. v. *MediaTek, Inc.*, et. al.
Case Number – ITC Investigation No. 337-TA-920. Amended complaint filed on May 27, 2014.
Case Subject Matter – Semiconductor integrated circuits and devices containing the same.
Work Performed – Provided expert consulting services.

DLA Piper (East Palo Alto and San Diego, CA)

Case – *GSI Technology, Inc.* v. Cypress Semiconductor Corporation
Case Number – IPR2014-00419. Petition filed on February 7, 2014.
Case Subject Matter – Semiconductor static random access memory (SRAM) circuit design.
Work Performed – Provided expert consulting services and wrote declaration for inter partes review.

Ropes & Gray LLP (Washington, DC)

Case – Macronix International Co., Ltd. v. *Spansion, Inc.*, et al.
Case Number – Virginia, ED (Alexandria) 3:13-cv-00679. Complaint filed on November 20, 2013.
Case Subject Matter – Non-volatile semiconductor flash memory fabrication and design.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

Cooley LLP (San Diego, CA)

Case – HSM Portfolio LLC and Technology Properties Limited LLC v. Fujitsu, AMD, *Qualcomm, Inc.*, Elpida, SK Hynix, Micron, ProMOS, SanDisk, Sony, ST Microelectronics, Toshiba, ON, and Zoran
Case Number – Delaware, 1:11-cv-00770. Third amended complaint filed on June 28, 2013.
Case Subject Matter – Semiconductor sensing circuits.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

DLA Piper (East Palo Alto and San Diego, CA)

Case – Cypress Semiconductor Corporation v. *GSI Technology, Inc.*
Case Number – California, ND 3:13-cv-02013. Complaint filed on May 1, 2013.
Case Subject Matter – Semiconductor static random access memory (SRAM) circuit design.
Work Performed – Provided expert consulting, claim construction, noninfringement analysis, and invalidity analysis.

Montgomery McCracken Walker & Rhoads LLP (Philadelphia, PA)

Case – Simon Nicholas Richmond v. Winchance Solar Fujian Technology, *Target*, *Creative Industries*, et. al.
Case Number – New Jersey, 3:13-cv-01954. Amended complaint filed on March 27, 2013.
Case Subject Matter – Circuitry including solar cells, charging circuits, re-chargeable batteries, energy conversion for solar lighting.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

DLA Piper (East Palo Alto, CA)

Case – Intellectual Ventures I/II LLC v. *Toshiba, Inc.*
Case Number – Delaware, 1:13-cv-00453. Complaint filed on March 20, 2013.
Case Subject Matter – Semiconductor memory and electronic interface circuits.
Work Performed – Provided expert consulting, noninfringement analysis, invalidity analysis, expert report, was deposed, and testified at trial.

Alston & Bird, DLA Piper, Gibson Dunn, Katten, O'Melveny, Orrick, and WilmerHale (various locations in the USA)

Case – Freescale v. *Funai*, *CSR*, *Zoran*, *MediaTek*, *Vizio*, *Sanyo*, *TPF*, *Top Victory Electronics*, *Envision Peripherals*, *AmTRAN*, and *Marvell*
Case Number – Texas, WD (Austin) 1:12-cv-00644. Amended complaint filed on January 14, 2013.
Case Subject Matter – Semiconductor circuitry for voltage regulators, bus terminations, packaging, and signal processing.
Work Performed – Provided expert consulting, claim construction, noninfringement analysis, invalidity analysis, and Markman tutorial.

Amin, Turocy & Watson LLP (San Jose and San Francisco, CA)

Case – *InvenSense, Inc.* v. Robert Bosch GmbH
Case Subject Matter – Microelectromechanical systems (MEMS) sensor design and manufacture.
Work Performed – Provided expert consulting services in 2013.

Morrison & Foerster LLP (Los Angeles, Palo Alto, and San Francisco, CA)

Case – STMicroelectronics, Inc. v. *InvenSense, Inc.*
Case Number – California, ND 3:12-cv-02475. Complaint filed on May 16, 2012.
Case Subject Matter – Microelectromechanical systems (MEMS) sensors including Gyroscopes and accelerometers.
Work Performed – Provided expert consulting, noninfringement analysis, invalidity analysis, and wrote declaration.

Kilpatrick Townsend & Stockton LLP (Menlo Park and San Francisco, CA)

Case – Consultant for *SK hynix*, Inc. on matters relating to investigation of certain patents owned by Round Rock Research LLC
Case Subject Matter – Semiconductor random access memory.
Work Performed – Provided expert consulting services in 2012.

Keker & Van Nest LLP (San Francisco, CA)

Case – Round Rock Research LLC v. *SanDisk Corp.*
Case Number – Delaware, 1:12-cv-00569. Complaint filed on May 3, 2012.
Case Subject Matter – Semiconductor non-volatile flash memory.
Work Performed – Provided expert consulting including: invalidity analysis, noninfringement analysis, expert reports, and was deposed.

Perkins Coie LLP (San Diego, CA)

Case – *ASUS Computer International* v. Round Rock Research LLC
Case Number – California, ND 3:12-cv-02099. Complaint filed on April 26, 2012.
Case Subject Matter – Semiconductor memory and image sensors (CMOS imagers).
Work Performed – Provided expert consulting, claim construction, noninfringement analysis, invalidity analysis, expert reports, and was deposed.

Morgan, Lewis & Bockius LLP (Palo Alto, CA)

Case – Dr. Michael Jaffe' as insolvency administrator for Qimonda AG v. LSI, *Atmel Corp*, Cypress, MagnaChip, and ON Semiconductor
Case Number – California, ND 3:12-cv-03166 (San Francisco). Complaint filed on January 10, 2012.
Case Subject Matter – Semiconductor processing and manufacturing.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

Useful Arts IP (Cupertino, CA)

Case – Tezzaron (formerly Tachyon Semiconductor) v. *Elm Technology Corporation*
Case Number – Patent Interference No. 105,859. Declared on December 1, 2011.
Case Subject Matter – Packaging of semiconductors and through silicon vias (TSVs).
Work Performed – Patent interference, wrote declaration, and was deposed.

Morgan, Lewis & Bockius LLP (Palo Alto, CA)

Case – Nanya Technology Corporation v. *Elpida Memory, Inc. and Kingston Technology Company, Inc.*
Case Number – ITC Investigation No. 337-TA-821. Complaint filed on November 21, 2011.
Case Subject Matter – Semiconductor DRAM design, fabrication, and manufacture.
Work Performed – Provided expert consulting and reports on validity, infringement, and domestic industry. Also provided declarations and was deposed.

Morgan, Lewis & Bockius LLP (Washington, DC)

Case – *Elpida Memory, Inc.* v. Nanya Technology Corporation
Case Number – ITC Investigation No. 337-TA-819. Complaint filed on November 15, 2011.
Case Subject Matter – Semiconductor DRAM design, fabrication, and manufacture.
Work Performed – Provided expert consulting and reports on infringement, domestic industry, and validity. Also provided Markman tutorial, declarations, deposition, and testimony at the trial.

Ropes & Gray LLP (New York City, NY)

Case – Intellectual Ventures v. *Sendai Nikon Corporation*
Case Number – Delaware, 1:11-cv-01025. Complaint filed on October 26. 2011.
Case Subject Matter – CMOS image sensor design and manufacture.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

Farella Braun + Martel LLP (San Francisco, CA)
Case – Round Rock Research LLC v. *Dell, Inc.*
Case Number – Delaware, 1:11-cv-00976. Complaint filed on October 14, 2011.
Case Subject Matter – Semiconductor DRAM design and manufacture.
Work Performed – Provided expert consulting, noninfringement analysis, invalidity analysis, and wrote declaration.

Latham & Watkins LLP (San Francisco, CA)
Case – Altera Corp. v. *LSI Corp. and Agere Systems, Inc.*
Case Number – California, ND 4:11-cv-03139. Complaint filed on June 24, 2011.
Case Subject Matter – Semiconductor devices and electronics including phase-locked loops and clock recovery circuits.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

Fish & Richardson P.C. (Washington, DC)
Case – Spansion LLC v. *Samsung Electronics Co., Ltd.*, Apple, Inc., Nokia Corp., PNY Technologies, Inc. Research In Motion Corporation, Transcend Information Inc.
Case Number – ITC Investigation No. 337-TA-735. Complaint filed on August 6, 2010.
Case Subject Matter – Semiconductor flash memory manufacture, fabrication, and design.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

Jones Day (Palo Alto, CA)
Case – LSI and Agere, Inc. v. *Xilinx, Inc.*
Case Number – New York, SD 1:09-cv-09719. Complaint filed on November 23, 2009.
Case Subject Matter – Semiconductor digital design and clocking.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

Morrison & Foerster LLP (New York City, NY)
Case – Innurvation, Inc. et al v. *Fujitsu Microelectronics America, Inc.*, Sony Corporation of America, Toshiba America Electronics Components, Inc., and Freescale Semiconductor, Inc.
Case Number – Maryland, 1:09-cv-01416. Complaint filed on May 29, 2009.
Case Subject Matter – Semiconductor circuit layout.
Work Performed – Provided expert consulting, noninfringement analysis, and invalidity analysis.

Wilson Sonsini Goodrich & Rosati P.C. (Palo Alto, CA)
Case – Panavision Imaging, LLC, v. *OmniVision Technologies, Inc.*, Canon U.S.A., Inc., Micron Technology, Inc., Aptina Imaging Corporation, and Aptina, LLC.
Case Number – California, CD 2:09-cv-01577. Complaint filed on March 6, 2009.
Case Subject Matter – CMOS image sensor (CMOS imager) design, fabrication, and manufacture.
Work Performed – Provided expert consulting, noninfringement analysis, invalidity analysis, two expert reports, and wrote declaration.

McDermott Will & Emery (Menlo Park, CA)
Case – Volterra Semiconductor Corp. v. Primarion & *Infineon Technologies North America & Infineon Technologies, A.G.*
Case Number – California, ND 3:08-cv-05129. Complaint filed on November 12, 2008.
Case Subject Matter – High-performance analog and mixed-signal power management semiconductors and switching power supplies in CMOS using power MOSFETs.
Work Performed – Provided expert consulting, noninfringement analysis, invalidity analysis, two expert reports, and was deposed.

Morrison & Foerster LLP (Palo Alto and San Francisco, CA) and Baker Botts LLP (Austin and Houston, TX)

Case – Power Integrations, Inc. v. *Fairchild Semiconductor International, Inc.*

Case Number – Delaware, 1:08-cv-00309. Complaint filed on May 23, 2008.

Case Subject Matter – Power conversion and power management integrated circuits used as power supplies for cell phones, LCD monitors, and computers. Circuits and techniques for the reduction of electromagnetic interference (EMI) and radio-frequency interference (RFI).

Work Performed – Provided expert consulting services, expert report, was deposed, and testified at re-trial for damages in November, 2018.

pre-2008 Minor expert witness work. Was deposed twice, once as an expert witness and the other time as a corporate witness.

(12) INNOVATION PATENT
(19) AUSTRALIAN PATENT OFFICE
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(54) Title
Lighting system

(51)[7] International Patent Classification(s)
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H05B 037/00 **F21V 023/06**
F21S 004/00

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ABSTRACT

A system 10 is disclosed for connecting an electrical device such as a lighting element 50 to a power source 11. The electrical device includes electrical couplings 55,56 in the form of metallised strips which are operative to form a capacitive coupling with respective conductive elements 24 disposed in an array on a supporting surface. The conductive element 24 on the supporting surface are connected to the power supply. In the preferred form, the electrical device is in the form of a light tile which includes embedded LEDs 59 and control and sensing devices (60,61) which are able to receive and transmit data via the signal path used by the power source. The lighting tile 50 is operative to be secured to the supporting surface via a magnetic force so that the tile may be simply and easily fixed to and removed from the supporting surface.

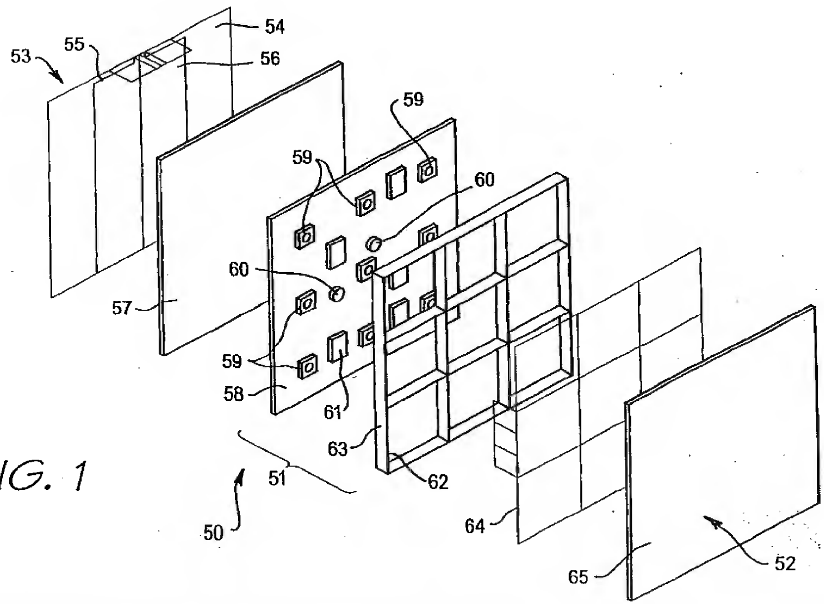


FIG. 1

1/9

Appx1180

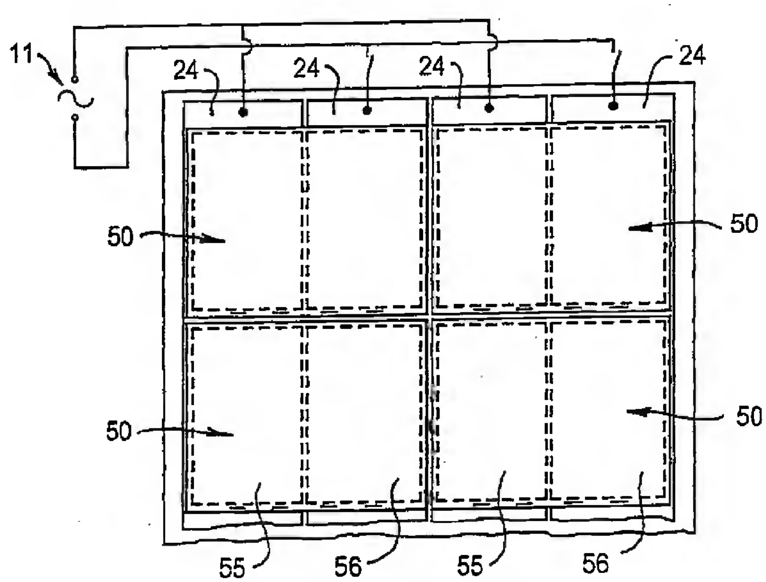


FIG 3

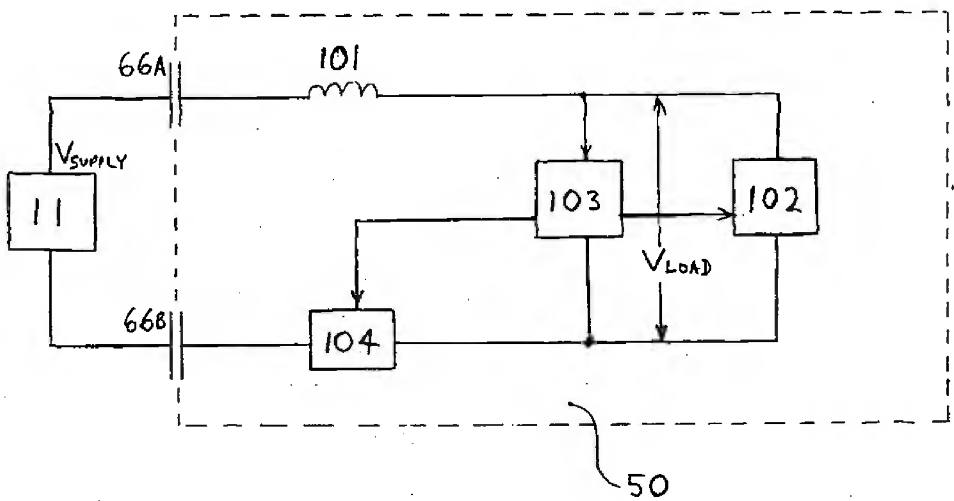

66A
101
VSUPPLY
11
103
102
VLOAD
66B
104
50

FIG. 11

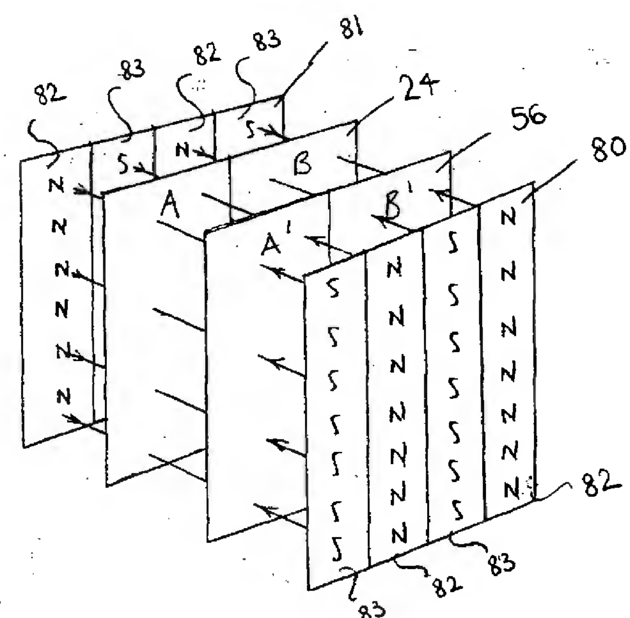

81
82
83
82
83
24
56
80
A
B
A'
B'
82
83
82
83

FIG. 12

AUSTRALIA

Patents Act 1990

COMPLETE SPECIFICATION

INNOVATION PATENT

Applicant(s):

FLAT WHITE LIGHTING PTY LTD

A.C.N. 095 596 302

Invention Title:

LIGHTING SYSTEM

The following statement is a full description of this invention, including the best method of performing it known to us:

LIGHTING SYSTEM

The present invention relates generally to systems and methods for connecting electrical devices to power sources. The invention has been designed especially but not exclusively for, lighting systems to illuminate wide areas, and the invention is herein described in this context. However, it is to be appreciated that the invention has broader application and may be used in conjunction with other electrical devices or other lighting arrangements such as those used in information displays, signage, feature lighting, decorative lighting or advertising lighting or the like.

Several problems exist when implementing a lighting system using currently available lighting elements. Flush mounting requires a co-operating surface behind which the light fittings may be mounted. This surface will thus encroach into the room space and render a portion of the volume of the room space unusable. Further, the location, size and quantity of the light fittings and controls must be decided to suit the perceived or present needs. If these needs change then it is difficult to change the locations, size or quantity of the light fittings or controls, due to the fixed wiring and physical mounting requirements of each device. If a change is made then the supporting structure would most likely require structural and surface repair to remove evidence of a change to the lighting system.

An aim of the present invention is to ameliorate the above problems by providing an improved system for connecting electrical devices to a power source. The invention is ideally suited to lighting systems and may enable that lighting system to have the functionality and aesthetics of a currently available lighting element but exhibit enhanced flexibility for installation and control.

In the broadest terms, the present invention relates to a system for connecting an electrical device to a power

source, the system providing for an electrical coupling between the electrical device and an energised surface associated with the power source and comprising:

- at least two conductive elements disposed at or adjacent an exterior surface of the electrical device,
- a supporting surface including an array of conductive elements connectable to the power source to form the energised surface,

wherein the array of conductive elements and the supporting surface are arranged such that, when the electrical device is contacted with the energised surface in any one of a plurality of selected positions, the conductive elements of the electrical device make a capacitive coupling with some of the conductive elements located on the supporting surface so as to couple capacitively the electrical device to the power source.

A particular advantage of this arrangement is that the device may be coupled to the power source without requiring any direct connection between the respective conductive elements of the device and the supporting surface. As a result the connection may be made without any physical damage to the supporting surface. A further advantage of this form is that the capacitive coupling provides a non-dissipative current limiting element for the device. Also the device may be hermetically sealed without exposed conductive elements that may oxidise or pose a hazard.

In one aspect, the present invention relates to a system as described above and further comprising an inductive device disposed in series with the load on the electrical device, wherein the inductive device is operative to be in at least near resonance at the power supply frequency with the capacitance of the capacitive coupling so as to improve the power transfer from the power supply to the electrical device. The net impedance of a series inductor and capacitor approaches zero as the circuit approaches resonance, thereby improving the

efficiency of the power transfer to the load.

In a preferred form of this aspect of the invention, the system further comprises a microcontroller that monitors power transfer to the load, and a variable impedance device, wherein the impedance is able to be varied in response to the level of power transfer measured by the microcontroller.

In the context of the specification, the electrical device relates to electrical appliances and apparatus that in the past were usually required to be connected to a power source by fixed wiring. The advantage of the present invention is that the electrical device is able to be disposed on the supporting surface to provide the electrical connection with the power source. As such the need to provide any significant structural changes to the supporting surface in installation of the device is obviated.

The electrical device preferably is a lighting element.

The system is ideally suited to a broad range of electrical devices including lighting systems, entertainment systems, security systems, sensors, transducers and other control devices.

In situations where the lighting element is suitable for use in wide area lighting, the supporting surface is typically a wall or ceiling. However the invention is not limited to this application and may be used in other decorative, feature or advertising situations. For example, the supporting surface may be an advertising display, or a piece of furniture such as a table surface where the lighting element is used for a particular purpose (such as reading) or as a feature.

When the electrical device or the lighting element is mounted on the supporting surface, the at least two electrically conductive elements of the electrical device or the lighting element are brought into close and substantially parallel relationship to the electrically

conductive elements of the supporting surface. To provide the desired capacitive coupling, an electrically insulating layer needs to be disposed between the electrically conductive elements of the supporting surface and the or each electrically conductive element of the electrical device or the lighting element. This may be achieved by an insulating overlay on either the electrical device (or the lighting element), or on the supporting surface or on both.

In one form, the array of electrically conductive elements of the supporting surface are mounted on a backing sheet which forms the first electrically insulating layer. The sheet may also include the second electrically insulating layer. This sheet may be produced in continuous lengths and be secured to said supporting structure as a surface coating in a similar fashion to wallpaper. Suitable materials here are metallised polymer or metallised paper without backing, with a flexible backing sheet of polymer, paper, rubber or silicone or with a rigid backing insulator such as plasterboard. Non-metallic conductive material may also be used to form the conductive elements. These include conductive polymer inks or carbon or silver based conductive materials applied to a film. These materials have the advantage of ease of application for small feature size.

In another form, the array of electrically conductive elements of the supporting surface are mounted on a rigid backing material such as plasterboard. A second electrically insulating layer may then be included. The advantage of this form is that only one process is needed to fix both the plasterboard and the electrical elements and insulator as the integral means for capacitively coupling the device or the lighting element.

In one form, the second insulating layer on the supporting surface may include or be comprised of the surface finish suitable for the area. This may be a typical paint finish. An advantage of this form is that

the energised electrically conductive plates and insulators are invisible and undetectable to the users of the space behind the painted surface. A further advantage of this form is that the surface finish itself can contribute to the improved efficiency of the power transfer across the capacitive coupling by including a high dielectric constant material such as titanium dioxide.

In the case where there are more pairs of electrically conductive elements on the electrical device or the lighting element than are coupled to the corresponding area of electrically conductive elements on the supporting surface then these are suitably interconnected by circuit elements on the device or the element so that capacitive coupling to a power source requires a progressively lower degree of lateral or angular precision when positioning the lighting element onto the supporting surface. An advantage of this is that a lower level of skill is then required to install the device onto the supporting structure surface to achieve a higher level of positioning accuracy.

In a further form, the electrically conductive elements on the supporting structure are configured to have a smaller area with larger breaks while still remaining on the same or proportional period as the corresponding electrically conductive elements on the electrical device or lighting element. An advantage of this is that the net coupling capacitance remains relatively constant for a full range of positioning tolerances.

The electrical device or the lighting element may be secured to the supporting surface in any suitable manner such by mechanical fasteners or through an adhesive or the like. However, in a preferred form, the device or the element is affixed adjacent to the supporting structure by a permanent magnetic force. The magnetic force is exerted between a magnetisable material located on or in the

supporting surface and a magnetisable material located on or in the body of the device.

In a further aspect, the invention relates to a system as defined above wherein the electrical device is securable to the supporting surface by a magnetic force exerted between first magnetisable material(s) located on or in the supporting surface and second magnetisable material(s) located on or in the electrical device, wherein the first and second magnetisable materials are each polarised to result in a regular pattern of north and south magnetic poles at or near the respective affixing surface so that the magnetisable materials are operative to guide the location of the electrical device into a predetermined alignment on the supporting surface.

In a preferred form, this predetermined alignment correlates with accurate alignment of the conductive elements on both the supporting surface with the conductive elements on the electrical device. In a particularly preferred form, the repeat period of the conductive strips is made to be proportional to the repeat period of linear polarised bands on the magnetisable material.

The electrically conductive elements on both the supporting surface and the electrical device or the lighting element may be a material that is not ferromagnetic, so as not to attenuate the magnetic force exerted between the device and the supporting surface. Alternatively the electrically conductive elements on either the supporting surface of the electrical device or the lighting element may be both conductive and ferromagnetic thereby integrating both the functions of conduction for electrical power coupling and magnetic receptor for affixing.

Suitable materials for use as active permanent magnets are ferrous oxide based flexible magnetic sheet, ferrite, alnico or rare earth permanent magnets. Magnetisable material may already be included in the

supporting surface such as reinforcing bar in concrete structures. Suitable materials are any ferromagnetic material.

In a further preferred form, the electrical device or the lighting element consists of or includes integrally embedded electronic manual controls such as touch switches or light level controls, remote controls such as radio frequency or infra-red, automatic controls such as clock timers or automatic light level controls or sensors such as occupancy, ambient light, temperature, smoke, proximity or other human or environmental sensors, or transducers such as sound wave generators or electro-chemical converters or a combination of any of these controls, sensors and transducers. Data communication between devices or elements including controls or sensors and devices or elements without controls or sensors may be achieved by means of wireless techniques such as radio frequency, infra-red or direct connection such as modulation of the external power source used by the device. In this way, devices (or elements) including controls, sensors or transducers can serve to control other devices (or elements) without controls or sensors, thus eliminating the need for other wired control or sensing elements. Another advantage is that devices or elements can be individually addressed in a networked data environment without the constraints of fixed wiring. A further advantage is that the same external power source connection can be used by devices or elements including controls or sensors as may be used by those without controls or sensors.

The arrangement of being able to provide both data and power through the electrical coupling may have broad application, particularly in enabling co-ordinated control of separate electrical devices. This can be particularly applicable for centralised control of electrical devices within a residential property. For example, entertainment or information display systems, such as televisions,

computer monitors, DVD players, CD players, radio receivers and audio speakers may be connected to the energised surface so that their power and control functionality is co-ordinated through the electrical coupling to thereby enable them to be networked with the other devices which are similarly connected. In this arrangement, control data may be transferred by the energised surface, whereas information data may be transferred using other known techniques such as infrared or radio frequency.

In one form, control of the resonant state of the series resonant circuit in accordance with an earlier form of the invention also provides a means to modulate data onto the electrical supply for other electrical devices or the power supply to receive. In this aspect, the microcontroller digitally modulates the load current of the electrical device by the control of the impedance element and/or the load with a serial data packet. The electrical device transmits these as a series of high and low current pulses.

The power supply demodulates the data packet for local processing or repeating back to other electrical devices attached to the system. In one form the power supply makes use of frequency shift keying techniques to modulate data back to electrical devices attached to the system. The advantages of this form are that it provides greater noise immunity and also allows for simplified demodulation circuitry on the electrical devices attached to the system.

As indicated above, the system can have broad application and can be used in conjunction with electrical devices which were previously hard wired to their power supply. A further specific application where the invention can have particular benefit is that as an underwater electrical system. When used in that application, the system can be used in water sanitation by electro chlorination via electrodes. In that application,

the electrical device incorporates the electrodes, and sacrificial or fouled electrodes which require regular replacement and can be easily removed and replaced by the capacitive coupling system. Another water sanitation method is the electro-chemical conversion of a metal to ions, commonly copper, silver, zinc or a combination of these. In that application, the electrical device incorporates sacrificial electrodes which require regular replacement and can be easily removed and replaced by the capacitive coupling system. An underwater electrical device may be used for lighting in one or many colours. Light colour may be changed as a result of many external conditions such as music, temperature or time of day. An underwater electrical system may also include water occupancy sensing for water safety monitoring or monitor water quality comfort parameters and communicate these back to a central point for monitoring and control via the data communication system. Furthermore, the underwater electrical system can be combined to carry out any combination of these features above thereby providing a complete solution for particular applications.

As indicated above, the system is ideally suited for use as part of a lighting system and in a further aspect, the present invention provides a lighting element suitable for connection to a power source using the system above-defined for connecting an electrical device to a power source. The lighting element comprises a body having opposite first and second major surfaces, at least one light source mounted to the body to emit light and at least two conductive elements disposed at or adjacent to one of the surfaces arranged to form a capacitive coupling with an energised surface.

In a particularly preferred form, the light source is embedded within the element body between the opposite major surfaces. This arrangement is ideally suited for mounting on surfaces such as walls, windows or ceilings where it can be installed without requiring a recessed

cavity to house components of the lighting source. As such, the element can significantly reduce the amount of space required to mount the lighting elements.

The body of the lighting element may be provided in different sizes and shapes and may also be rigid or flexible. In one form, the body of the lighting element may be in the form of a sheet like material of indefinite length whereas in another form the body may be more compact and formed in the shape of a tile or the like. Further, the body may be of a unitary structure or may include a combination of materials in 'a laminated or other arrangement. The body may also be solid or incorporate voids or passages. In one form the body displays even light diffusion characteristics. In another form, the body may be constructed to display uneven light diffusion or focussed characteristics to produce a range of lighting effects.

Preferably the body includes a layer in which the light source is embedded or to which the light source is attached. Suitable materials for this layer include transparent, translucent, white or colour tinted polymers such as polycarbonate, transparent, translucent, white or colour tinted silicone, transparent, translucent, white or colour tinted fused material such as glass or a combination of polymer, fused material and silicone.

In one form, the at least one light source is an LED. These typically have a life of around 100,000 hours. An LED light source or sources may be embedded directly into the body of the lighting element utilising intrinsic material thermal conductivity for thermal management. In one form the at least three light sources are red, green and blue LEDs. By controlling the amount of light emitted from each of these LEDs, most colours of light can be generated.

Other suitable light sources include resonant cavity, single mode or electronically powered photon recycling light-emitting diodes (LEDs) and LEDs other than compound

semi-conductor LEDs such as organic polymer LED materials. In addition, cold cathode fluorescent or electroluminescent light sources may also be suitable.

In a one form, the at least one light source is a white LED. These operate' by action of a mono-chromatic blue semi-conductor LED light activating a phosphor coating or layer. The phosphor coating or layer converts mono-chromatic light with a wavelength of blue light or shorter to substantially white light containing light of various wavelengths. However, LEDs of any available colour may be utilised as required.

The phosphor coating may be directly applied on to the LED. In an alternative form, the lighting element includes a phosphor layer disposed at or adjacent to the first major surface of the lighting element. In this way alighting element including blue LEDs may emit substantially white light. An advantage of performing the conversion at or adjacent to the first major surface is that the optical properties of the lighting element as a source of white light are improved over an arrangement where the phosphor coating is applied to the or each LED.

In a particularly preferred form, the body includes a layer of translucent material laminated with at least one electrically conductive layer. The at least one electrically conductive layer may facilitate electrical connections within the lighting element and may also provide the lighting element with additional mechanical strength.

The at least one electrically conductive layer may provide a planar optical reflector. The surface characteristics of said at least one electrically conductive layer may be optimised for uniform optical reflection to provide a uniform diffused light source. Alternatively the at least one electrically conductive layer may be generally transparent to allow other light sources to be seen through the lighting element.

In a particularly preferred form, the at least one

light source is positioned within the body. In the case of utilising more than one light source in a lighting element, these may be spaced within the body. However, the at least one light source may be positioned on any edge surface. Various applied optical methods may be employed within the body to produce even diffused light output, focussed or directional light output as required.

The lighting element according to this aspect of the invention is ideally suited for use in the system described above. In particular the lighting element may be designed to be capacitively coupled to the power source using the techniques mentioned above and may include a magnetisable layer so as to be able to be secured to the supporting surface by receptive force.

A preferred form of the present invention provides a lighting system wherein a thin and generally planar lighting element may be releasably affixed to a surface, such as a wall, and powered via capacitive coupling formed between electrically conductive elements positioned on the back of the lighting element and on the surface to which the lighting element is attached. Further, the lighting elements may be controlled by data transmitted with the power supply.

It is convenient to hereinafter describe embodiments of the present invention with reference to the accompanying drawings. It is to be appreciated that the particularity of the drawings and the related description is to be understood as not superseding the generality of the preceding broad description of the invention.

In the drawings:

Figure 1 is an exploded view of a light tile for use in the lighting system according to an embodiment of the invention;

Figure 2 is a side elevation showing the lighting tile of Figure 1 mounted on a support structure of the lighting system;

Figure 3 is a front elevation in schematic view

illustrating four of the lighting tiles of Figure 1 mounted on the surface and connected to a power source;

Figure 4 is a simplified circuit diagram of of one lighting tile illustrated in Figure 3;

Figure 5 is a schematic view of an alternate circuit arrangement of the support structure of the lighting system of Figure 2;

Figure 6 is a schematic view of the lighting system using an alternative lighting tile to that disclosed in Figure 1;

Figure 7 is a simplified circuit diagram of the lighting system of Figure 6;

Figure 8 is a more detailed circuit diagram;

Figure 9 is a block diagram of the lighting tile circuitry including sensor and control functions;

Figure 10 is a block diagram of the network of the lighting system;

Figure 11 is an alternative circuit diagram including a series resonant circuit;

Figure 12 is a schematic view of an alternative magnetic coupling system for use in the tile of Figure 1.

Figure 13 is an alternative circuit diagram to the circuit disclosed in Figure 11; and

Figure 14 is an alternative arrangement of conductive strips for use in the tile of Figure 1.

Figure 1 illustrates in exploded view, a lighting tile 50 for use in a wide area lighting system 10. The lighting tile 50 has a thin body 51 having opposite first and second major surfaces (52, 53). The body 51 is of layered structure made of six main components.

The rear most component 54. has an outer surface which forms the second major surface or back face 53 of the body 51. This component is made from a polymer film which includes metallised strips 55, 56 disposed on an inner side thereof. The metallised strip 55, 56 act as electrical coupling elements for the tile 50 to enable it to be capacitively coupled to a power source as will be

described in more detail below.

The polymer film forms an insulating layer over the metallised strips 55 and 56 thereby fully securing the electrical coupling elements within the tile body 51.

The next layer of the tile body 51 is a flexible magnetic sheet 57 which provides an active magnetic force to secure the lighting tile to an appropriate magnetic receptive element. As will be described in more detail below, the use of a magnetic force to mount the tile to a supporting structure is ideally suited to the lighting system 10 as it provides a convenient system whereby the tile 50 may be secured and removed from a supporting structure which incorporates an appropriate magnetic receptor without damage to that supporting structure.

The next layer of the tile body includes a printed circuit board subassembly 58 which provides the mechanical support for circuitry and the electrical components to provide the various functions of the lighting tile 50. In the illustrated form, mounted on the circuit board 58 includes nine LEDs 59 which are set out in a 3 x 3 grid format. Sensors 60 are also disposed on the circuit board 58. The exact nature of the sensors may vary depending on the required functionality of the lighting tile 50. The sensors may include, but not limited to, any one or combinations of the following: pyroelectric sensors, long wave length infrared sensors, microwave proximity sensors, ultrasonic proximity sensors, infra-red short wave detectors for remote control, photosensors for visible light level detections, temperature sensors, humidity sensors, air pressure sensors, smoke detectors, RF transmitter or receiver modules, microphone, video image capture, infra-red image capture, and touch sensor conditioning electronics.

Also mounted on the circuit board, is at least one microcontroller 61 to control the various light tile functions. This controller 61 typically controls the total amount of energy available to all the LEDs and is able to

control individual LED brightness, to accept signals from sensors to convert to a local or remote report or command, and to construct and transmit data messages for remote reporting or command. The controller may also be structured to interpret and act upon received data reports or commands. The circuit board 58 also includes data circuits to modulate and demodulate signal as well as to recover the data clock signal. Also power supply circuitry is incorporated such as bridge rectifiers and energy storage components.

The next adjacent layer of the lighting tile is a supporting frame 62 which locates over these components mounted on the circuit board to thereby provide some physical protection to those components. Typically, the frame is made from an injected moulded polycarbonate but other suitable materials may be used. The frame 62 may also provide the external edge 63 to the light tile body.

The next layer is a further metallised polymer film 64 which acts as a touch sensor to enable the lighting tile 50 to be controlled, to at least some extent by human touch on the first major surface 52 of the tile body. In the illustrated form, the selective metallised polymer film 64 provides lines of horizontal and vertical fine metallisation on a clear polymer film. In this way it acts as a high impedance capacitive pick up for human touch sensing.

The final component of the tile body 51 is a front cover which provides an optical correction for emitting light using defusion, defraction,- focussing or other applied optical techniques. The front cover may also provide a long wave length infra-red fresnel lens embossing to improve or to rationalise a pyroelectric sensor field of view if required. Further, the front cover may provide optical lenses for incoming video or infra-red image capture again depending on the required functionality of the lighting tile 50.

The lighting system 10 is designed so that the

lighting tile 50 is to be mounted to a supporting structure 20 and coupled to a power supply 11 by a capacitive coupling arrangement.

With reference to Figures 2 and 3, the supporting structure is illustrated as a wall and includes an outer surface overlay 22 which is specifically to provide one part of the capacitive coupling and also to enable the lighting element 50 to be mounted to the wall 20 by a magnetic force generated by the magnetic sheet 57.

The surface overlay 22 is best illustrated in Figure 2. It is to be appreciated that the coatings are not drawn to scale so as to more easily represent the main component features. The surface overlay 22 is a laminated structure which is applied to the wall 20. The surface overlay 22 includes an outer polymer film 23 which includes metallised strips 24 and a magnetic receptive layer 25. The surface overlay 22 is constructed so that the metallised strip 24 are located intermediate the polymer film 23 and the magnetic receptive layer, each of which provide Insulating layers for the metal strip.

In a similar arrangement to that disclosed in respect of the lighting tile 50, the metallised strips act as electrical coupling elements which form part of the capacitive coupling arrangement of the lighting system 10. In particular, as best illustrated in Figure 3, each of the metallised strips is connected to the power supply 11 which in the illustrated embodiment is a 48 Volt AC power supply.

As indicated above, the surface coating 22 is designed to be applied to the supporting structure 20. In use, the surface coating can be provided over a wide area of the supporting structure 20 and may be fixed to a supporting structure in one step in a similar manner to hanging wallpaper. As a 48 Volt AC power supply is used, the system does not present an electric shock hazard to persons or animals.

In use, the lighting tile 50 is placed against the

surface overlay 22 of the support structure with the second major surface 53 of the tile facing towards the support structure 20. In view of the proximity of the magnetic sheet 57 to the magnetic receptive layer 25 of the surface overlay 22, the tile can be secured in place solely by the magnetic force. Further, the tile is positioned on the supportive structure 20 so that the metallised strips 55, 56 are aligned with pairs of the metallised strips 24 formed on the surface coating. When mounted in this manner, capacitors 66 are formed between the aligned pairs of strips which serve to couple the lighting elements to the power supply.

Figure 12 illustrates an alternative arrangement of magnetic sheets (80 and 81) which are designed to replace magnetic sheets 57 and 25 respectively. In this arrangement the magnetic sheets (80 and 81) include bands 82,83 linearly polarised alternatively with north and south magnetic poles. These magnetic sheets are aligned with the corresponding conductive strips 56 and 24 with the order of the polarised bands 82, 83 on sheet 80 being the reverse of the sheet 57. The repeat period of the conductive strips 56 and 24 is made to be proportional to the repeating period of the polarised bands 82, 83 on the magnetisable material.. In the illustrated form, the period of the conductive strips 56 and 24 is twice that of the period of the magnetic polarised bands 82, 83.

With the arrangement as illustrated in figure 12, a system is provided for automatic and accurate alignment of the capacitor plates on the electrical device to the capacitator on the supporting surface as the polarised bands with the north magnetic pole on the tile 50 are attracted to the polarised bands with the south magnetic pole on the magnetic sheet 81 on the supporting surface. Further when the polarised magnetic strips align it causes the capacitor sheets to also align so as to facilitate the maximum power transfer.

Referring to Figure 4, a simplified circuit diagram

for a lighting tile 50 in the lighting system 10. The nine LEDs 59, are shown connected to diodes 67 located on the circuit board 58. The diodes are configured to form a bridge'rectifier. This configuration ensures that light is emitted from the LEDs during both the positive and negative cycles of the AC power supply coupled via capacitors connections 66. Not shown in this circuit diagram are other circuit elements that may be used to control any or all of the LEDs and other circuit elements that may be used to perform any of the previously mentioned control or sensing functions.

In the embodiment illustrated in Figure 3, switches 12 may be incorporated in the electric circuit to enable specific areas of the array to be selectively activated to thereby control operation of the lighting tile 50 mounted thereto. In an alternate arrangement illustrated in Figure 5, some of the metallised strips 24 in the surface coating 20 are discontinuous with those discontinuous portions being independently connected to the power supply 11. Each of these connections may also include switches 12 to enable more selective activation of areas *of* the supporting structure. When the lighting elements include the control functionality as discussed in more detail below, the need for switches is obviated.

Whilst not shown, the surface coating may also include a typical paint finish so that the energised surfaces are not readily distinguished from a normal wall. A further advantage *of* a surface finish such as paint is that it in itself can contribute to the efficiency of the power transferred across the capacitive coupling by including a higher dielectric constant material such as titanium dioxide.

Whilst the embodiment of the lighting tile 50 shown in Figure 1 incorporates only two metallic strips, a larger number of strips or diametrically opposed conductive strips may be provided so that the capacitive coupling to a power source requires a progressively

lowered degree of lateral or angular precision when positioning the lighting elements onto the supporting structure. An advantage of this is that a lower level of skill is then required to install the lighting element onto the supporting structure to achieve a desired resolution of connection.

Figure 6 shows an arrangement where the lighting tile 70 include four conductive strips (55A, 55B, 56A, 56B). The spacing of the metallic strips is an integer fraction of the width of the conductive strips 24 on the supporting structure. This ensures that maximum power is transferred to the lighting element.

Referring to Figure 7, a simplified circuit is shown to achieve the maximum power transfer in the case where there is four electrically conductive strips on the lighting element 70. The electrical outputs are combined via multiple groups of diodes 71 formed as bridge rectifiers (or equivalent rectification circuits). Constructive current summing is then achieved to feed LEDs 59. In any of the above arrangements other numbers of LEDs can be used in a series or parallel connection. To illustrate the operation of a lighting tile 50 capacitively coupled to a power supply according to the invention it will be convenient to set out a worked example.

Referring to Figure 8, a simplified circuit diagram of a lighting element including nine LEDs is shown capacitively coupled to an AC power supply. It will be convenient to illustrate how to determine approximately what frequency of power supply will satisfactorily illuminate the LEDs.

The impedance of a capacitor is given by the following equation:

$$\frac{Z= 1}{2Tr\ f\ C}$$

Where f is the frequency of the power supply and C is the

capacitance of the capacitor.

Furthermore, the impedance of a capacitor may also be determined by the following equation:

$$Z = \frac{V}{I}$$

Where V is the voltage drop across the capacitor and I is the current flowing through it.

Combining the above two equations to solve f gives:

$$f = \frac{I}{V2rrC}$$

It is necessary to determine the capacitance of both CA and Cs, these being capacitances provided by the arrangements of electrically conductive plates. The capacitance of two parallel plates is calculated as follows:

$$C = \frac{kCoA}{d}$$

Where:

- k is the dielectric constant of the material between the plates of the capacitor. For the purpose of this example k will be taken to be 6.
- Eo is the permeability of a vacuum, which is 8.9 x 1012 c2/Nm2.
- A is the area of the plates. For the purpose of this example the dimensions of each plate are 0.1m x 0.05m Thus producing an area of 0.005M2
- d is the distance between the plates. For this example d is 0.05mm or 0.00005m.

Therefore, the capacitance of each of CA and CB

$$= \frac{6x8.9x10\text{-}12X0.005}{0.00005}$$

$$= 5.3 \times 10^{-9} F$$
$$= 5.3 nF$$

Diodes and LEDs conduct electricity non-linearly and will also have varying characteristics, consequently the following is a simplified calculation to illustrate the approximate magnitudes of parameters. For normal operation of the LEDs of Figure 9 the voltage drop VAB will be 1.5 volts for diodes 67 plus 3.5 volts each for LEDs 59. Total voltage drop VAB will be 33 volts and an average current of 20 mA will flow through the LEDs. Thus, when using a 48 volt power supply, the voltage drop across each capacitor in Figure 8 is given by:

$$\frac{(48 - 33)}{2} = 7.5 volts$$

Thus, substituting the known values of current, voltage and capacitance into the equation derived above for solving f we arrive at:

$$f = \frac{0.02}{7.5 \times 2 \times n\ 5.3 \times 1\ 0}$$

$$= 80kHz$$

Thus, a 48 Volt AC power supply of 80kHz will satisfactorily illuminate the LED's of Figure 8.

Pulse Width Modulation (PWM) techniques (Class D) may be used to efficiently generate sine wave power of suitable electrical characteristics. This has the advantage of efficient and simple power conversions.

Perceived light output intensity may be increased by using microcontroller 61 to pulse larger current through the LEDs 59 whilst maintaining the same average current

drain.

The capabilities of the capacitive coupling may be improved by increasing the capacitances of the capacitors formed in the coupling. This may be achieved by utilising a dielectric material with a higher dielectric constant in the insulating layer. In addition, the elements of the capacitors may be positioned closer together. Thirdly, the coupled capacitive surface area may be increased using complex surface area techniques without increasing the overall tile dimensions. Fourthly, the AC frequency of the power supply may be increased.

As mentioned above, the lighting element may include sensors 60, and a microcontroller 61 to accept and receive signals and to provide control over the LEDs.

With reference to Figure 9, the light tile circuitry is structured so that all data is transferred by the same electrical path that is used for the electrical power transfer, that is via the two capacitors formed when the tile is in intimate contact with the supporting structure. With this arrangement, data is superpositioned on the primary power.

Each light tile 50 is able to transmit data under control of the microcontroller 61 through the data modulator 80 transmitted over the electrical path and extracted on another tile or device via a data demodulator 81. A clock recovery circuitry 82 is also included within the lighting element 50 to recover a clock of identical frequency to the primary power. Systemwide synchronous data transmission is then facilitated by this clock.

Figure 10 illustrates the light tiles connected in a local network. As can be seen the power supply 11 incorporates a modulator and demodulator circuit 83 to allow external data networks or external control to communicate with the light tile network. The power supply is supplied by a circuit element that presents a low impedance to the primary power but a high impedance to the data modulation signal. This thereby minimises the

attenuation by the power supply of the superimposed data signals.

In operation, the lighting system enables all data to be broadcast over the whole light tile system. Each light tile is given a unique address at its time of manufacture and this address is stored in a non volatile memory. To initialise the system, a central controller may be required to allocate dynamic and semi-permanent address allocation for use during operation as required by the system. For example, this would allow particular light tiles to be logically grouped for example to allow a number of units to be controlled by a single message.

Once the system is fully initialised with the central controller, that controller is no longer required to enable communication between light tiles and/or the power supply and external systems. For a message to be successfully delivered, only one device is permitted to transmit at any time. Further, all devices can receive at all times and will only act upon messages addressed to that device. Message collisions are managed by the control device using multiple repeat, acknowledge or random time to retry methods as necessary. The data structure implemented is one of multi-byte data packet supported by a two-byte cyclic redundancy check sum to detect data errors. Additional parity checking may also be used.

Figure 11 illustrates a modification to the circuit which is arranged to improve the energy transfer. Specifically, the circuit includes an inductor 101 which is included in series with the load 102 on the electrical device 50.

With this arrangement, the coupling capacitors 66a and 66b in series with inductor 101 and complex variable impedance elements 104, comprise the energy storage elements of the series resonant circuit. The inductor 101 is calculated to result in series resonance with the net capacitance formed between the electrical device 50 and the supporting surface at the power supply frequency. The

inductor 101 is also chosen such that its series resistance energy dissipation is small with respect to the energy dissipated in the load. Further a microcontroller 103 is included to monitor full maximum power transfer and to adjust one value of the series resonance circuit on the electrical device to maintain maximum power transfer. The microcontroller monitors the voltage across the load and varies the impedance of element 104 to maintain a near resonance state and hence maximum power transfer for all extreme values of the elements of a series resonance circuit.

Referring to Figure 13, a simplified circuit is shown to achieve the maximum power transfer in the case where there are more electrically conductive elements on the electrical device or lighting element 70 than on the supporting structure in the corresponding area and when the series resonance power transfer is used. Specifically Figure 13 illustrates the case where four electrically conductive elements (55A, 55B, 56A, 56B) on the electrical device or lighting element are coupled to two electrically conductive elements 24 on the supporting surface in one of two possible positions. One position being that as illustrated in Figure 13, the other being when the device is moved laterally so that current flows through elements 55A, 55B and exits via 55B and 56A. In the case as illustrated, the electronic switches 105 and 107 are on and electronic switches 106 and 108 are off. In the other position switches 105 and 107 are off while switches 106 and 108 are on.

An advantage of this arrangement is that a single inductor 101 and related series resonance circuitry can be used per electrical device or lighting element. Suitable electronic switch elements are two Metal Oxide Semiconductor Field Effect Transistors (MOSFETs) connected in common source series configuration. Automatic activation of respective switches is achieved by rectifying the voltage on the next adjacent conductive

element to supply suitable gate drive to turn the MOSFETS on. If the next adjacent conductive element is at the same potential, for example switches 106 and 108 in Figure 13, then no gate drive is supplied and the switches remain off.

The control of the resonance state of the series resonance circuit by the electrical device provides a means to modulate data on to the electrical supply for other electrical devices or the power supply to receive. Specifically in this mode of operation, the microcontroller 103 can digitally modulate the load current of the electrical device 50 by control of impedance element 104 and/or the load 102 with a serial data packet. The electrical device 50 transmits these as a series of high and low current pulses. The power supply 11 demodulates this data packet for local processing or repeating back to other electrical devices attached to the system. In one form the power supply makes use of frequency shift keying techniques to modulate data back to electrical devices attached to the system. The advantages of this form are that it provides greater noise immunity and also allows for simplified demodulation circuitry on the electrical devices attached to the system.

Figure 14 illustrates a modification that facilitates series resonance operation. The electrically conductive elements on the supporting structure 24 are configured to have a smaller area with larger gaps while still remaining on the same or proportional period as the corresponding electrically conductive elements on the electrical device or lighting element, 55 and 56. An advantage of this is that the net coupling capacitance remains relatively constant for a full range of positioning tolerances.

In operation of the lighting system 10 an energised surface is created by virtue of the surface coating 22 connected to the power supply 11. The lighting tile element 50 can then be affixed and capacitively coupled to the energised surface with a large degree of flexibility

of location. Further, these tiles can be removed without marking the energised surface in view of the magnetic attraction and capacitive coupling which is used to connect the light tile to the light network and support that tile against the supporting structure. In view of the control functionality, and sensors embedded within the lighting tile, data is able to be transmitted between the light tile enabling a broad range of control functions to be implemented on that tile.

Finally, it is to be understood that alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A system for connecting an electrical device to a power source, the system providing for an electrical coupling between the electrical device and an energised surface associated with the power source and comprising:

- at least two conductive elements disposed at or adjacent an exterior surface of the electrical device,
- a supporting surface including an array of conductive elements connectable to the power source to form the energised surface, and
- an inductive device disposed in series with the load on the electrical device

wherein the array of conductive elements and the supporting surface are arranged such that, when the electrical device is contacted with the energised surface in any one of a plurality of selected positions, the conductive elements of the electrical device make a capacitive coupling with some of the conductive elements located on the supporting surface so as to couple capacitively the electrical device to the power source, and wherein the inductive device is operative to be in at least near resonance at the power supply frequency with the capacitance of the capacitive coupling so as to improve the power transfer from the power supply to the electrical device.

2. A system according to claim 1, further comprises a microcontroller that monitors power transfer in the circuit, and a variable impedance device, wherein the impedance device is able to be varied in response to the level of power transfer measured by the microcontroller.

3. A system according to claim 2, wherein data is modulated onto the electrical supply by varying the impedance device and/or load impedance under control of the microcontroller.

4. A system according to any one of claims 1 to 3, wherein the electrical device is able to be capacitvely

coupled to the supporting surface in a plurality of modes, and wherein in each mode, a different arrangement of conductive elements of the electrical device are capacatively coupled to the conductive elements of the supporting surface, and wherein the system further comprises a plurality of switches which interconnect the conductive elements of the electrical device, the switches being operative in response to a potential difference to automatically to maintain said circuit in each of said plurality of modes.

5. A system for connecting an electrical device to a power source, the system providing for an electrical coupling between the electrical device and an energised surface associated with the power source and comprising:

- at least two conductive elements disposed at or adjacent an exterior surface of the electrical device,
- a supporting surface including an array of conductive elements connectable to the power source to form the energised surface,

wherein the array of conductive elements and the supporting surface are arranged such that, when the electrical device is contacted with the energised surface in any one of a plurality of selected positions, the conductive elements of the electrical device make a capacitive coupling with some of the conductive elements located on the supporting surface so as to couple capacitively the electrical device to the power source, and wherein the electrical device is securable to the supporting surface by a magnetic force exerted between first magnetisable material(s) located on or in the supporting surface and second magnetisable material(s) located on or in the electrical device, wherein the first and second magnetisable materials are each polarised to result in a regular pattern of north and south magnetic poles at or near the respective affixing surface so that the magnetisable materials are operative to guide the location of the electrical device into a predetermined

alignment on the supporting surface.

Dated this 18th day of March 2003

FLATWHITE LIGHTING PTY LTD

By their Patent Attorneys

GRIFFITH HACK

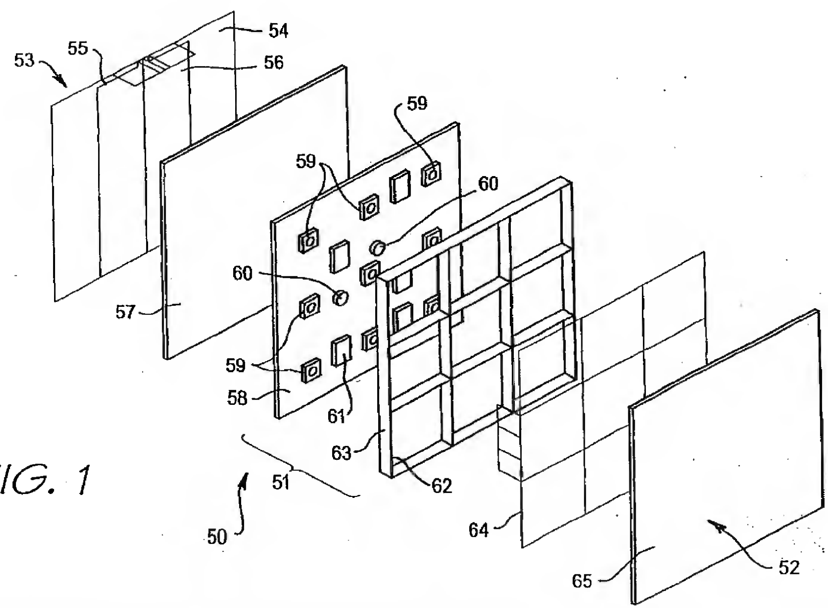


FIG. 1

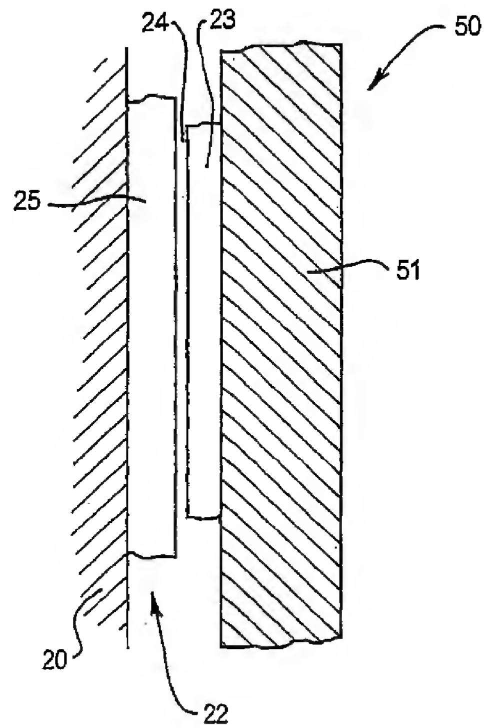


FIG 2

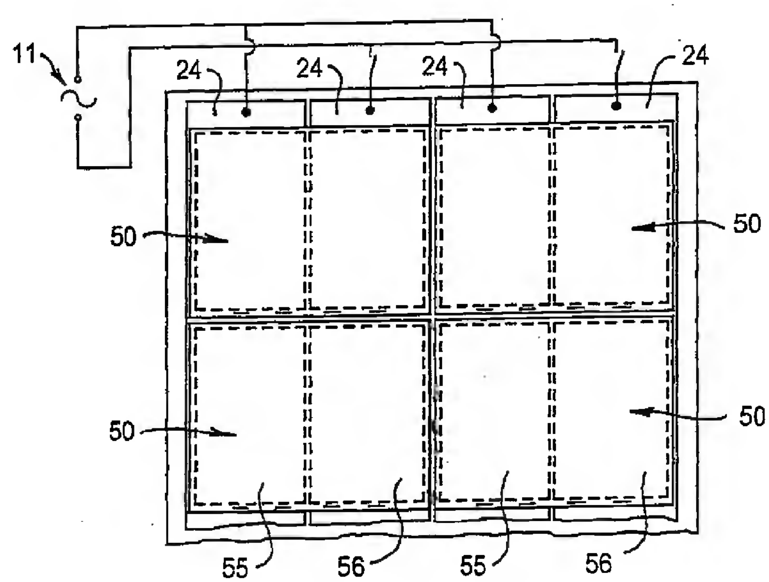


FIG 3

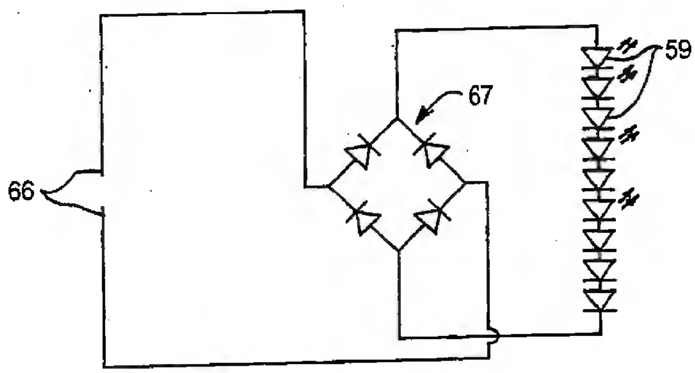


FIG 4

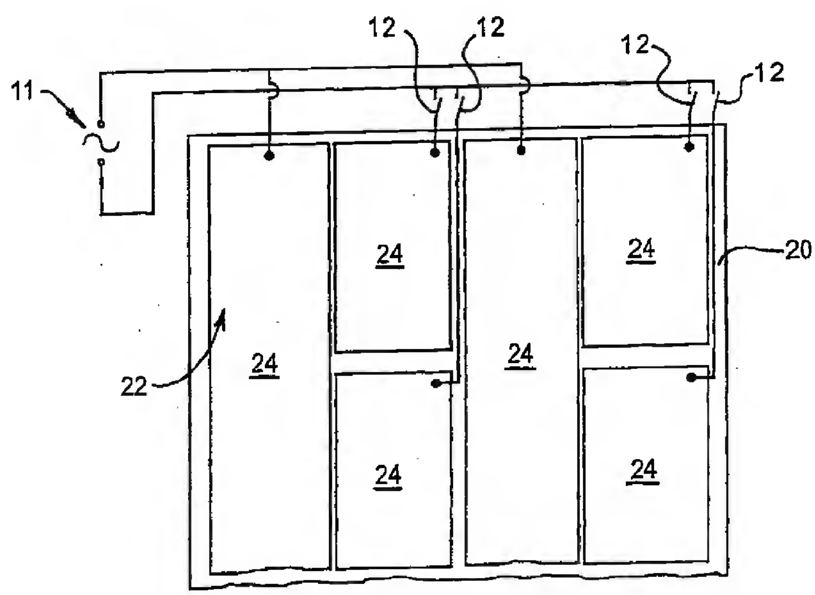


FIG 5

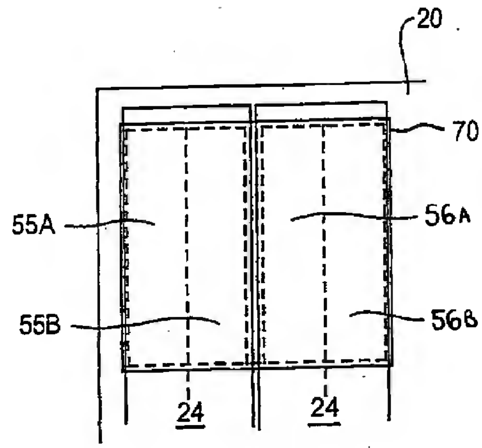


FIG 6

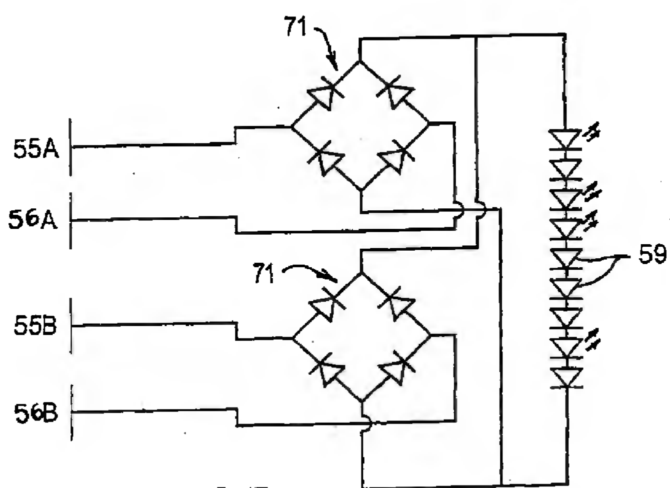


FIG 7

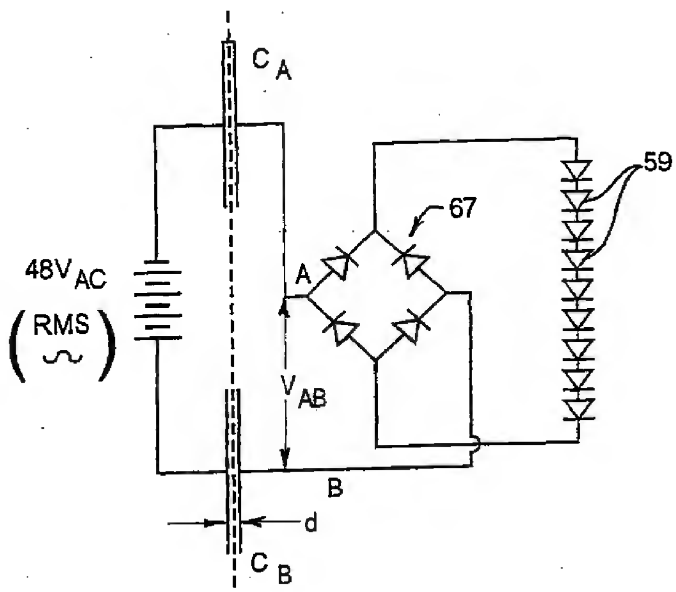


FIG 8

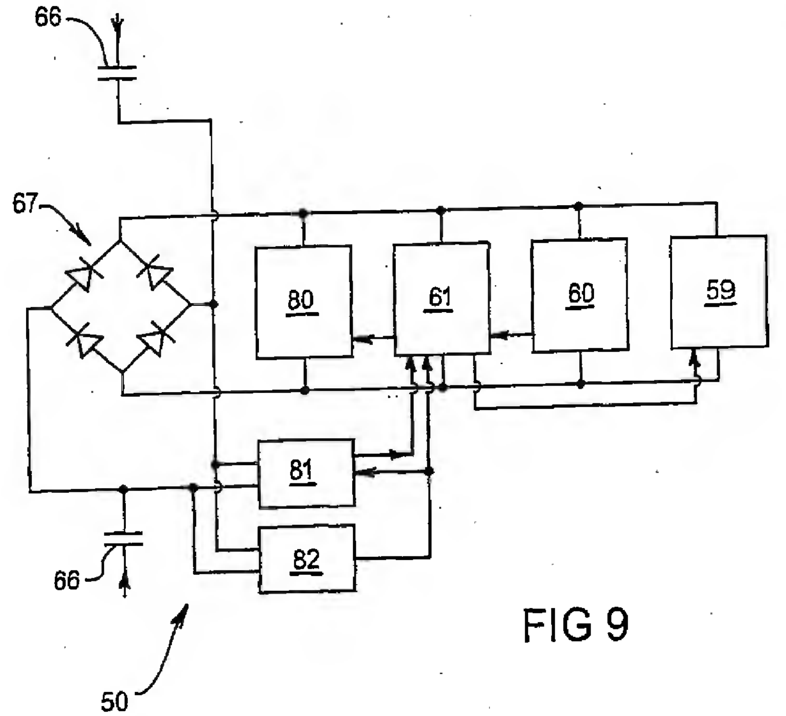


FIG 9

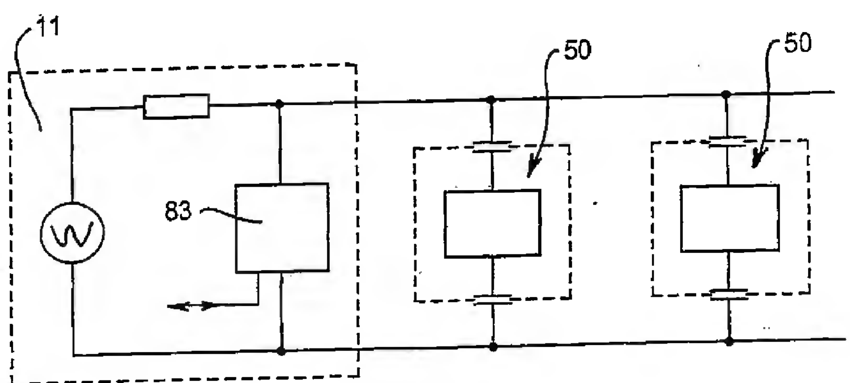
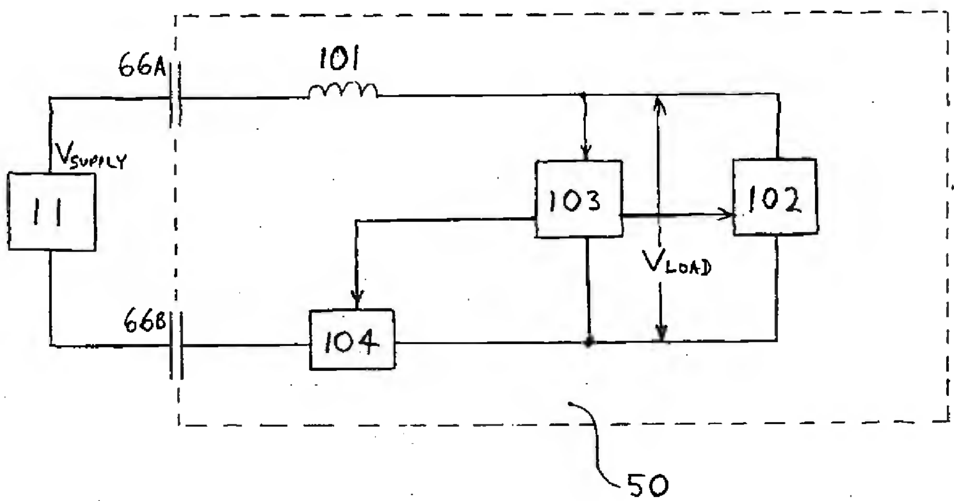
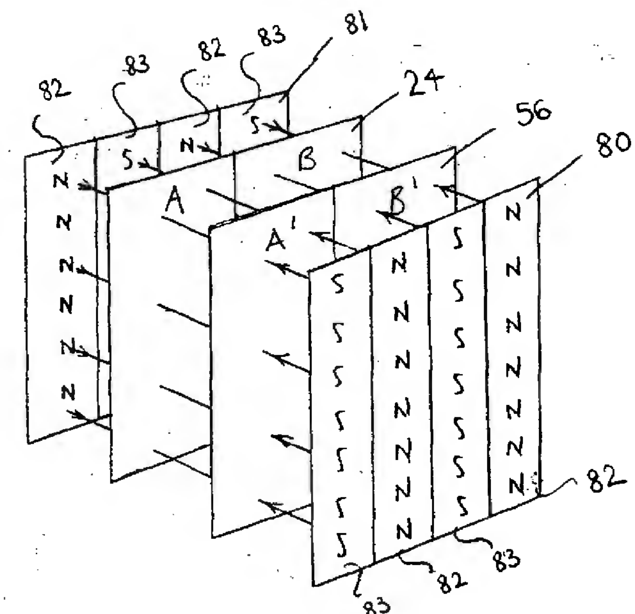


FIG 10



66A
101
V_{SUPPLY}
11
103
102
V_{LOAD}
66B
104
50

FIG. 11



81
82
83
82
83
24
56
80
A
B
A'
B'

FIG. 12

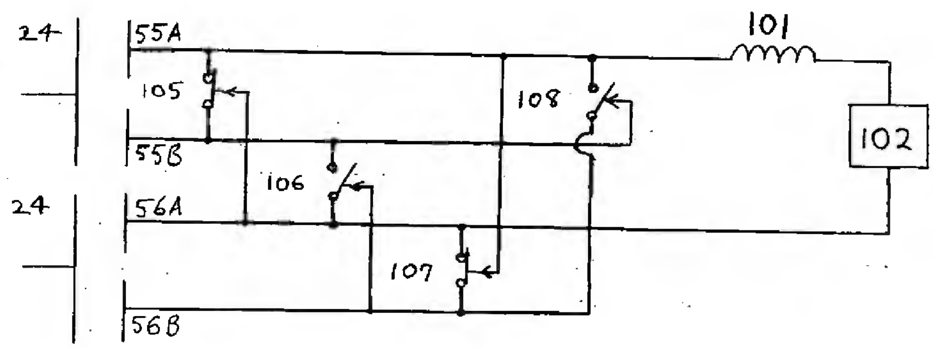


FIG. 13

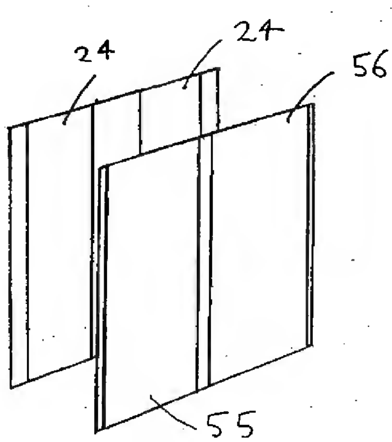
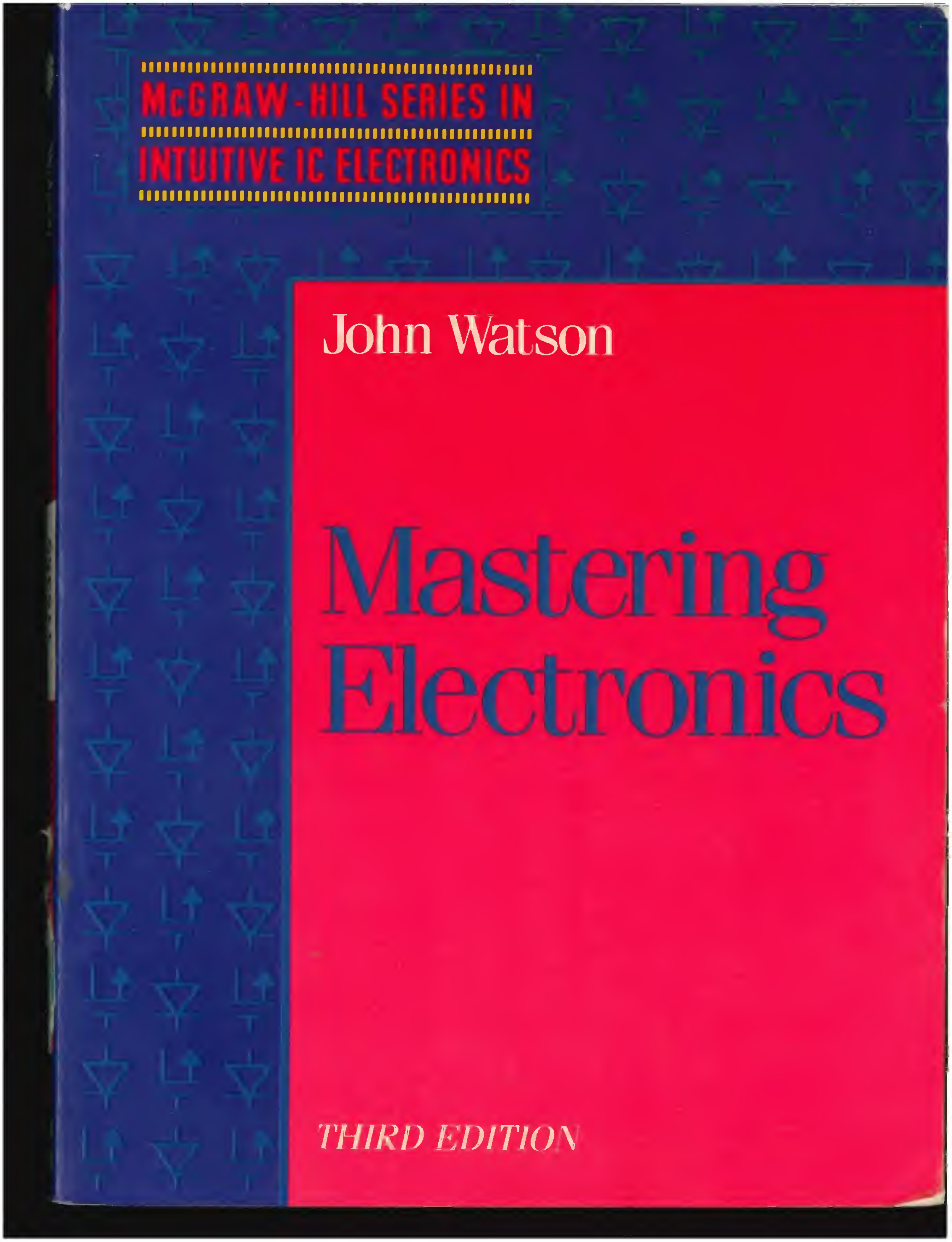


FIG. 14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an electromagnetic switch, the coil being used to operate a mechanical switch. However, the coil has inductance. A relay operating from a 6 V supply can, when suddenly disconnected, produce an output pulse of 100 V or more as the current flowing through it drops very rapidly to zero. This voltage may be high enough to harm semiconductor components, and precautions should be taken to ensure that this 'spike' of high voltage is made harmless.

3.5 POWER SUPPLIES

I am going to introduce, prematurely, a semiconductor component that is described fully in Chapter 7. This is the *diode*, a sort of electronic one-way street that will let current pass through it in one direction but not in the other direction.

Diodes are used in power supply circuits, in association with transformers. A transformer is used to reduce the voltage of the a.c. mains to something more usable in electronic circuits, say 10 V in this case. However, the output is still a.c., and most electronic circuits require a direct current supply. The transformer's output can be converted, or *rectified*, by one or more diodes. Figure 3.18 shows a transformer operating a circuit with a bulb. The waveform of the voltage across the bulb is shown also.

Now compare the waveform with the one in Figure 3.19. The diode has blocked current flowing in one direction, so the top connection of the bulb is always positive. Only half the power reaches the bulb, so this is not a very efficient design. If four diodes are used, in a configuration called a *bridge rectifier*, the whole of the current available from the transformer can be passed through the bulb. Follow the current path through Figure 3.20, first for one direction of output from the secondary, and then from the other.

fig 3.18 *waveforms at the input and output of a transformer driving a lamp*